



Meeting the challenges of an increasingly

divERSe
work force



W O M E N I N A S T R O N O M Y A N D S P A C E S C I E N C E

WOMEN IN ASTRONOMY AND SPACE SCIENCE
**Meeting the Challenges of an Increasingly
Diverse Workforce**

Proceedings from the conference held at
The Inn and Conference Center
University of Maryland
University College
October 21—23, 2009

Edited by Anne L. Kinney, Diana Khachadourian, Pamela S. Millar and Colleen N. Hartman

IN MEMORIAM

Dr. Beth A. Brown
1969-2008



Dedication to Beth Brown

Fallen Star

Howard E. Kea, NASA/GSFC

She lit up a room with her wonderful smile; she made everyone in her presence feel that they were important. On October 5, 2008 one of our rising stars in astronomy had fallen. Dr. Beth Brown was an Astrophysicist in the Science and Exploration Directorate at NASA's Goddard Space Flight Center. Beth was always fascinated by space: she grew up watching Star Trek and Star Wars, which motivated her to become an astronaut. However, her eyesight prevented her from being eligible for astronaut training, which led to her pursuing the stars through astronomy.

Beth pursued her study of the stars more seriously at Howard University where she majored in physics and astronomy. Upon learning that her nearsightedness would limit her chances of becoming an astronaut, Beth's love for astronomy continued to grow and she graduated summa cum laude from Howard University.

Beth continued her education at the University of Michigan in Ann Arbor. There she received a Master's Degree in Astronomy in 1994 on elliptical galaxies and she obtained her Ph.D. in 1998, becoming the first African-American woman to earn a doctorate in Astronomy from the University of Michigan.

After completing her graduate work, Dr. Brown came to NASA Goddard as a National Academy of Science/National Research Council (NAS/NRC) Post-Doctoral Research Associate. In 2001, she was appointed as an Astrophysicist Fellow in the NASA Administrator's Fellowship Program (NAFP) and was named a Visiting Assistant Professor at Howard University. Her most recent position was Assistant Director for Science Communications and Higher Education in the Science and Exploration Directorate at NASA Goddard Space Flight Center.

The astronomy community mourns the loss of Dr. Brown for her contributions to the field of astronomy and her contributions in inspiring women and minorities to pursue careers in astrophysics. The Women in Astronomy and Space Science Conference 2009 and proceedings book are dedicated to the memory of Dr. Beth A. Brown (1969-2008).

Organizing Committees

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Amy Simon-Miller, NASA GSFC
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Rob Strain

Director, Goddard Space Flight Center

Foreword

We at the Goddard Space Flight Center were pleased to host, together with our colleagues at the University of Maryland, this conference on diversity in astronomy. These topics are deeply important to us as we continually recruit and train a highly talented workforce which leads the way in designing, building, and performing science on some of the world's premier scientific space facilities.

One of the interesting aspects of the progress of women, who only a generation ago made up a small percentage of the astronomical workforce, is the degree to which women mentored each other, self organized, and shared lessons-learned, resulting in a field which today has a much more equitable percentage of women. Now that there is progress in the entrance of minorities into astronomy, we must do more than hope that lessons-learned can be put to use. Strategies for success of minority scientists were discussed at the conference including Bridge Programs involving Historically Black Colleges and Universities, focusing on the transition from high school to college, and the transition from undergraduate to graduate school. Engaging the HBCUs is an important aspect of increasing the representation of minorities in the sciences.

One recurring theme of the meeting is the power of mentoring in all its forms: formal mentoring, informal mentoring, peer mentoring, and group mentoring. Creating an atmosphere where there is engaged interaction, especially bridging the gap between senior career and early career scientists, can set the stage for all forms of mentoring. While senior career scientists may have worked alone in their offices, early career scientists are part of a generation that shares knowledge and experience in a more fluid environment.

NASA and the Goddard Space Flight Center are dedicated to investing in our future. It is our highly accomplished and dedicated scientists and engineers drawn from a broad and diverse pool of talent that will create that future.

Rob Strain
Director, Goddard Space Flight Center
Greenbelt, MD
May 6, 2010

Acknowledgements

The Editors

The Organizing Committee for WIA III 2009 worked for over a year putting together the concepts behind our meeting. These large weekly discussions were later replaced by focused discussions with the Local Organizing Committee hammering out the details. We would like to thank the Organizing Committee for enduring many long Friday meetings that provided the backbone behind the conference. The early discussions were critical to our understanding of which issues needed to be taken up at this particular time. We would also like to thank the Local Organizing Committee that did the heavy lifting for all the details of contacting speakers and working out logistics. A very warm thank you to Amy Simon-Miller, Ann Hornschmeier, Felicia Jones-Selden, Howard Kea, Dara Norman, Hashima Hasan, and Jim Gass. Jay Friedlander, the GSFC photographer and media specialist, gets a special thanks for recording all the talks which we were later able to transcribe, for managing all the audio and video equipment, for providing slide shows of photos from previous meetings, and for photographing the events, including the visit to the White House. Jay's excellent photos are featured throughout this book.

We would like to thank the Goddard Space Flight Center, and especially Nick White for being very supportive from the first suggestion that GSFC take the lead in organizing this meeting. Also, we would like to thank Doris Daou, Cheryse Triano, and the NASA Lunar Science Institute for helping with the publication of this book.

The University of Maryland was a real partner in putting together this meeting, with Eric McKenzie of the Astronomy Department serving as our point of contact. We really appreciate Eric's constant support.

Without the support of the National Aeronautics and Space Administration and the National Science Foundation this meeting would not have happened. We are very grateful for the support provided by both NASA and the NSF.

We would also like to express our gratitude to the sponsors who supported our meeting: American Astronomical Society, Associated Universities, Inc., Association of University for Research in Astronomy, Committee On the Advancement of Women in Chemistry (COACH), European Space Agency, Harvard-Smithsonian Center for Astrophysics, Jet Propulsion Laboratory, The Johns Hopkins University Applied Research Laboratory, Maryland Space Business Roundtable, Northrop Grumman Space Technology, Space Telescope Science Institute, University of Maryland Astronomy Department, and University Space Research Association. With the support from these organizations we were able to hold receptions, offer networking breakfasts for early career scientists, and host a networking event in the evening, all allowing for more time for interaction between early career scientists and more senior scientists. The success of this meeting is owed in large part to the support of these sponsors.

I . I N T R O D U C T I O N



ANNE KINNEY

Director, Solar System Exploration Division, GSFC

Opening Remarks

Anne Kinney, Director, Solar System Exploration Division, GSFC
Chair of Women in Astronomy and Space Science III,
2009 Organizing Committee Presented at the Inn and Conference Center,
University of Maryland, University College
October 21, 2009

We were excited by the response to our meeting, and were thrilled with the attendance of over three hundred people that included an energized cadre of early career scientists as well as mid career and senior scientists from fifty-seven different universities. We were especially pleased to have in attendance managers and mentors of the scientific workforce representing: Carnegie Observatories, Gemini Observatory, Harvard Smithsonian Center for Astrophysics, Jet Propulsion Lab, National Optical Astronomical Observatories, National Radio Astronomy Observatory, National Science Foundation, NASA Headquarters, NASA Ames, NASA Goddard, NASA Langley, NASA Marshall, Massachusetts Institute of Technology, Planetary Science Institute, Search for Extraterrestrial Intelligence, Space Telescope Science Institute, Spitzer Science Center, and Yale. Societies that represent scientists were also in attendance with the American Astronomical Society, American Institute of Physics, and American Physical Society were all well represented.

The topics of this meeting have focused on the senior scientists who mentor and manage the workforce, the mid-career scientists who face the full range of challenges, including balancing home and work, and the early career scientists who represent the future of the field. Our workforce now spans six generations, where the youngest scientists make up the most diverse group. The generational gap is simultaneously a cultural gap.

In the sixteen years since the first Women in Astronomy meeting, we have seen vast changes in the field. Women now make up a much larger fraction of the field than they did sixteen years ago, when American Astronomical Society membership for those under the age of thirty was less than 20% female, compared to today's 40%. Meanwhile, there have been few changes in the presence of minorities in the field.

I believe that the rapid progress of women in the field is due in part to the sharing of lessons learned within what was for years a disenfranchised cadre of female scientists, and by the ability of these scientists to mentor each other in a field where true mentoring is rare. As the field struggles to increase its diversity in underrepresented minorities, these lessons for success may be very valuable. One of the aims of this meeting was to capture some of these successful practices in the hope of applying them towards the success of minorities in astronomy and space science.

THE CHANGING SCIENTIFIC WORKFORCE

As a microcosm of this world, let me share with you the numbers for the Solar System Exploration Division at the Goddard Space Flight Center, that I now lead. There are one hundred Civil Servant scientists in the division, with approximately 60% senior, 20% mid-career, and 20% early career scientists.

Of the early career scientists, 50% are female, 10% are African American, 10% Asian/Pacific Islander, none Hispanic, and an unknown percentage of both Lesbian, Gay, Bisexual, Transgender individuals (GLBT), and People With Targeted Disabilities (PWTD), reflecting the hesitancy on the part of those communities to self disclose.

In comparison, the senior scientists are 10% female, with 1% minority. Mid-careers are approximately one-third female, 5% African American, and 15% Asian/Pacific Islander. Again, percentages of both GLBT and PWTD are unknown.

Meanwhile, at NASA, the highest status positions are those of Principal Investigator, Project Scientist, and Instrument Scientist. Of the twenty scientists playing these roles in Solar System Exploration Division, none are women, and one is Asian/Pacific Islander.

What is the precise status of this microcosm of the scientific workplace? One challenge has been overcome, with the pipeline for women up and running and producing highly competitive scientists, who are getting hired at a rate approaching 50%.

But several other challenges remain; with the pipeline for minorities needing a lot of attention, with a need for attention to the success of those women in the workforce, and with a need to increase awareness of GLBT and PWTD issues such that scientists are comfortable bringing up workplace problems of real concern to these multiple-minorities. Here also is the concise location of the wave of women in the science workforce; women

are present in large numbers at the junior level, which creates the impression that they have been fully accepted. Yet no female scientists have made it into the highest status positions of this particular workplace microcosm, the Solar System Exploration Division at Goddard Space Flight Center.

CONTENTS OF PROCEEDINGS

The topics of our conference encompass these concerns. In the proceedings there are several papers capturing the statistics for women in the field from Dr. Rachel Ivie of the American Institute of Physics, Dr. Claude Canizares on the National Research Council study, and finally from Dr. Catherine Cesarsky with international statistics for women in astronomy. Our proceedings contains papers concerning issues of bias, papers concerning the building of the next generation of scientists, a discussion on how institutions and professional societies can aid in retention and recruitment, and a discussion on paths to non-academic careers. Additionally there are papers addressing best practices of proposal submission, gender imbalance and diversity, career choices and work/life balance, previous Women in Astronomy meetings, and progress within Historically Black Colleges and Universities.

In addition, there are numerous papers focused on everything from how to become a Project Scientist, to marketing your science, how to set a lactation facility, and a brief section on history.

CONFERENCE HIGH POINTS

1. Creating an Atmosphere of Engaged Interaction

There were several important “ah-ha” moments for me at this meeting. First, we were able to create an atmosphere of engaged discussion, especially involving cross-generational interactions between scientists. For a field dominated by scientists who have better scientific skills than social skills, this was an accomplishment that served our purpose of transfer of best practices. We created this atmosphere at the conference by starting each day with a “networking breakfast,” where early career scientists signed up to sit at tables populated with various senior scientists. These breakfasts, held between seven and eight AM, served to kick off the day with interactions between junior and senior scientists, and they set the tone for the whole meeting. We thank the senior scientists who agreed to

show up at the un-scientific hour of seven AM, ready to engage our early career scientists in active discussion; Dr. Meg Urry, Dr. Debbie Elmegreen, Dr. Colleen Hartman, Dr. Ed Weiler, Dr. Mark Sykes, Dr. Kathie Olsen, Dr. Keivan Stassun, Dr. Barbara Williams, Dr. Fran Bagenal, and Dr. Laurie Leshin.

This activity is well worth imitating in any organization where sharing of lessons learned is important. Here at the Goddard Space Flight Center we are imitating it by setting up “networking breakfasts” between Emeritus Scientists and new hires, and by organizing lunches to facilitate communication between mentors and mentees. We aim to create an atmosphere where early career scientists communicate often and openly with senior scientists who can serve as both official and unofficial mentors.

2. Early Career Scientists in an Increasingly Challenging Environment

Dr. Canizares closes his paper by discussing the nature of the field that we have created. Scientists earn PhDs anywhere in the range from the ages of 25 to 35. They are then expected to have one to two post doctoral positions lasting approximately three years each. Then, at the ages of 31 to 41 they will “graduate” to a job at a salary level beyond that of an apprentice. If that job is a tenure track position, there could be an additional six years before achieving tenure. This challenging career track, where there is little stability or security for raising a family until a person is well into their 40’s, may be discouraging for all women and men, and increasingly discouraging for diverse female and male scientists.

There is a need to reach out to early career scientists and give them the tools to survive the ever-expanding obstacle course of our field. A good example of such an outreach program is the “Next Generation Lunar Scientists and Engineers Program,” headed by PIs Dr. Noah Petro and Dr. Lora Blecher, a three-year program funded from the NASA EPO for Earth and Space Science. The Next Gen Program goal is to enable members to become better equipped to contribute to the lunar program. The program organizes workshops for early career scientists prior to major meetings in Lunar Science. The program provides 24/7 communications and networking opportunities via the web as well as networking opportunities between junior and senior level lunar scientists with

an emphasis on the crossover between science and engineering. Their approach is one that could be readily adapted to help early career scientists be aware of and develop the survival tools needed in astronomy and planetary science.

3. Increasing Diversity

The final “ah-ha” moment for me concerned the situation with minority scientists. We had excellent presentations about the programs of Spelman College, the University of Maryland in Baltimore County (i.e. the Meyerhoff Program), and the Fisk Vanderbilt University Bridge Program. These programs are producing high quality minority students who are continuing into graduate school and into successful careers in science. This is a pipeline to which the field must pay attention.

While in the past the pipeline for minorities was under-populated, the situation is finally changing.

Astronomy has an opportunity to change its lack of diversity, but to do that we must pay attention to the situation. I suggest that the next meeting in the WIA series concentrate on the pipeline for minorities in astronomy and planetary science, with an emphasis on intern programs and workshops for early career scientists. I hope that NASA and NSF will be interested in supporting such an important effort.



EDWARD J. WEILER

NASA Associate Administrator for the Science Mission Directorate

Welcoming Remarks

Edward J. Weiler, NASA Associate Administrator for the Science Mission Directorate
Women in Astronomy Conference III, 2009
Presented at the Inn and Conference Center, University of Maryland, University College
October 21, 2009

Thank you Anne, and thank you ladies and gentlemen.

I am very happy to be the welcoming speaker at this conference on Women in Astronomy and Space Science. I think this is a great idea for a conference and I wish you well during the coming three days.

As your conference materials point out, this is not a conference just about the role of women in astronomy and space science, but rather, it is about the inclusiveness of space science for women and historically underrepresented minorities.

As some of you know, I have been an astronomer and space scientist for over 30 years. When I finished my doctorate at Northwestern in 1976, the role of women in astronomy was limited. Women astronomers and space scientists were solitary stars within their respective subfields, but they did not represent a significant percentage of the practitioners in astronomy.



To the left is a photo from the 2003 Lunar Planetary Science conference. Women and underrepresented minorities are visible. Compare this to the photo on the right taken at the 1972 Space Biology conference whose attendants were mostly men—only one woman and very few people of color among sixty-five people. The difference between these two photos is thirty-one years and not to say that there is not more to be done, but a lot has changed since then, and most of it has been for the better.

But the change has been gradual. For example, in the mid-1970s when I started my career, membership in the American Astronomical Society was about 10 percent female across all age brackets. Starting in the 1990s and forward, the fraction of women in the AAS has increased at the younger age brackets. Overall, the AAS is 25 percent female today, but this percentage increases substantially for members younger than 40. Kevin Marvel, the AAS Executive Director, estimates that roughly 35 percent of AAS members younger than 40 are women, and in the very youngest age brackets women are approaching 50%.

I was hired by a very competent woman, and I myself hired numerous talented women who became keys in their own right in managing well-known programs and missions.

As depicted on this graphical NASA Family Tree on the next page, Nancy Roman, who was a real pioneer for women in astronomy, and who I think is attending today, hired me in my first job as a NASA civil servant back in 1978.

In fact, I have the distinction of being the first male Chief of Astronomy at NASA. Nancy Roman held that position from its inception until I took over.



As I mentioned before, I have been lucky enough to have hired or promoted some stellar scientists, engineers, and managers myself. Some examples include:

Colleen Hartman. I encouraged Colleen to pursue her technical degree and later promoted her to be the Director of Solar System Exploration. There she started the In-space Propulsion Program, the New Frontiers Program, Project Prometheus, and was able to get the Pluto AO from start to final signature in two months—an unprecedented feat.

Anne Kinney. I also hired Anne to be the Director of the Astronomy & Physics Division. During her tenure, Anne was responsible for two Hubble Servicing Missions, and the launches of the Wilkinson Microwave Anisotropy Probe (WMAP), the Spitzer Space Telescope, the Galaxy Evolution Explorer (GALEX), the Cosmic Hot Interstellar Plasma Spectrometer (CHIPS) and Swift.

Yes, we can improve things. I've seen it done and I have been an active agent in ensuring that opportunity for all is a factor when putting my leadership teams together.

In the 1990s, NASA played a role in increasing the visibility of female astronomers and space scientists.

Some of you may remember when NASA press conferences were dominated by men. In these *before* pictures (right), taken from a 1991 pre-launch press conference for the Compton Gamma Ray Observatory, everyone involved in the press conference was a man.



Things started to change in the mid-to-late 1990s, when more women were given the opportunity to have a seat at the table—literally, as part of SMD's more modern and informational style of press conferences, called Space Science Updates. Women like Heidi Hammel and Melissa McGrath gathered around the table talking about the crash of Comet Shoemaker-Levy 9 into Jupiter; Wendy Freedman and Anne Kinney explaining HST results about the Hubble Constant; and Carolyn Porco revealing incredible images of the Saturnian system taken by the Cassini spacecraft.



The changes started to be seen within NASA also. But again the pace was sometimes very slow. For example, in 1980, only 5.2% of the permanent full-time scientific and engineering jobs at NASA were held by women. Today that number is just over 20 percent.



But change did come. As shown here, when I left what was then the Office of Space Science after six years as AA, my line managers reflected my commitment to opportunity for all. OSS was often referred to by folks on the 9th floor as the best run organization at HQ—and that’s because I chose the line managers who were best for the job, regardless of their demographics. As you can see, three of my division directors were women, and one division director and one associate director were historically underrepresented minorities.

In my subsequent job, as Center Director for the Goddard Space Flight Center, I put together an even more diverse group of senior leaders. In this case, I was only in that job for three years, but I was still able to get the right team in place.

These examples are not intended to toot my own horn, rather they are meant to show that senior managers with a commitment to opportunity for all can achieve a strong and diverse leadership team over time.



The truth is that women are taking on more and more line management positions within NASA missions. Right now, SMD has three female Principal Investigators: Fiona Harrison on NuSTAR, Maria Zuber on GRAIL, and Jean Swank on the recently selected GEMS mission.

Jean is particularly noteworthy for the historic collection of women she has identified for leadership roles in her PI-led missions. As seen here, in addition to the PI, the Program Executive; Program Scientist; Project Manager; Integration Manager; and the main instrument (the polarimeter), Systems Scientist, are all women.

Now, let's focus on the future and the role of outreach in making it better. In many ways this conference is about the future and where we go from here.

Great people enable great missions that, with a little investment in outreach, serve to inspire and educate both young and old. Outreach is what allows NASA and the scientists who work with NASA to give back to the larger community in a thousand different ways.

SMD spends about fifty million dollars a year on Education and Public Outreach (E/PO); most of it managed through our missions. When I left OSS, we had a rule that all missions had to spend 1-3% of their total resources on E/PO. When I returned to HQ in 2008, that number had been reduced to .25%. It's back up to a minimum of 1% now, and my managers know that they will be rewarded if they devote more than that minimum requirement to E/PO activities.



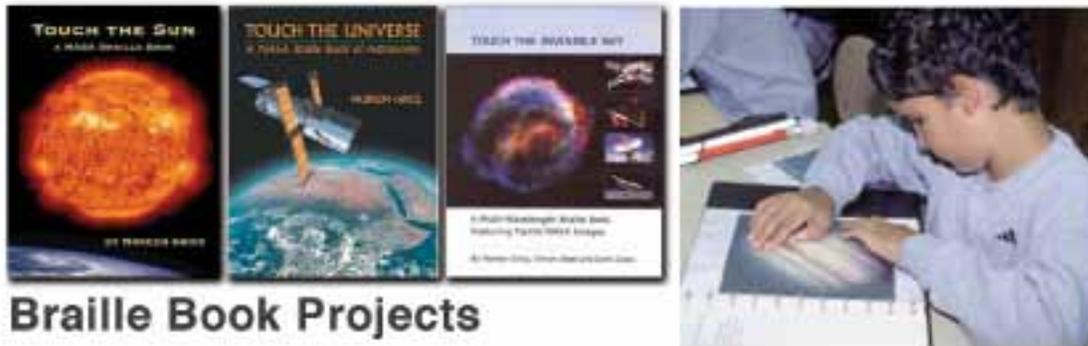
One of the biggest concerns this country faces is the relatively low numbers of young people going into the science and engineering fields.

One of the main goals of our outreach efforts is to inspire young people to think about getting into these fields where they may someday make huge contributions. This includes all young people, and it includes parents, too. Kids need to know that there is a future for them in science, math, engineering, and technology. And parents need to reinforce the natural curiosity that draws kids toward science, so that they can stick with it.



Our E/PO efforts have to reach out broadly. I'm very proud of all of the E/PO programs SMD has been involved with, but I'm especially proud of those that have focused on the blind. SMD has sponsored a number of Braille book projects that have provided opportunities for the visually impaired to "feel and see" what the solar system and universe are like. We need to do more to ensure that all of our children have a chance to be inspired by what we do in the space sciences.

All of us have heard the statistics over the years that young girls are much less likely to go into these fields. And that's why I think we are starting to make a difference.



Braille Book Projects

Kids sit through lots of talks by guys like me, and maybe I'll get them fired up, but it's not rocket science to realize that kids pay a lot more attention when someone who looks like them is giving the talk.



A lot of the women we've been fortunate to bring into NASA have devoted time and energy to talking to elementary and high school classes. I can't help but be a little more optimistic that we're making some progress and doing a better job of inspiring the half of our young population that used to be left behind when it came to science and engineering. And that may be one of our greatest legacies.

Thank you.

II. KEY TALKS



RACHEL IVIE

American Institute of Physics

Mentoring and the Imposter Syndrome in Astronomy Graduate Students

Rachel Ivie and Arnell Ephraim, Statistical Research Center, American Institute of Physics

SUMMARY

The longitudinal study of astronomy graduate students was designed to collect data on people who obtain graduate degrees in astronomy, to compare attrition for men and women, to collect data on people who leave the field of astronomy, and to collect data on astronomers who work outside the traditional employment sectors of academe and the observatories in order to explore barriers that may exist for astronomers in general and female astronomers in particular. The information in this report reflects only data from the first phase of the study, so conclusions about attrition and employment outcomes cannot be made yet. The framework for the first phase of the study was guided by several hypotheses. The main hypothesis was that feeling like an imposter in the field is more likely for female astronomy graduate students than for male. The imposter syndrome is a psychological construct defined as believing that one does not really belong in a field because of lack of true ability. Our results show support for this hypothesis.

BACKGROUND

In 2003, the Pasadena conference on Women in Astronomy adopted a resolution (later adopted by the AAS Council) that stated their interest in conducting a longitudinal study of women in astronomy using sound statistical methods. In response to this recommendation, the Committee for the Status of Women in Astronomy convened a working group to design a study to track graduate students in astronomy over several years. The working group members were Patricia Knezek, Audra Baleisis, Susana Deustua, Stefanie Wachter, Jennifer Neakrase and Rachel Ivie.

For this first survey, the working group was particularly interested in examining whether or not the imposter syndrome exists among astronomy graduate students. The imposter syndrome is the phenomenon of “believing that one’s accomplishments came about not through genuine ability, but as a result of having been lucky, having worked harder than others, and having manipulated other people’s impressions” (Langford & Clance, 1993). The syndrome is a psychological construct that has received attention in research literature and in the popular press. It is described as occurring frequently among graduate students (Laursen, 2008). The working group also wanted to measure the imposter syndrome because we believe that people who feel like imposters may be more likely to leave the field of astronomy.

The first phase of this study was funded by the AAS Council and the American Institute of Physics (AIP). The AIP Statistical Research Center (SRC) collected the data.

DATA COLLECTION METHODS

The target group for this study was U.S. astronomy and astrophysics graduate students during the 2006-2007 academic year. To survey these students, the SRC gathered contact information from the following: (1) the AAS junior membership list; (2) lists of graduate students supplied to the SRC by physics and astronomy departments; and (3) announcements in the AAS newsletter that invited students to contact the SRC if they wanted to participate in the study. The final contact list included 2,056 names.

The questionnaire was available on paper and on a secure website hosted by AIP. Initially, all students were contacted electronically. The SRC sent a notice describing the study, an invitation to complete the questionnaire on a secure website, follow-up email requests to complete the survey, and a special email to the students who started the survey on the web but did not complete it. Paper versions of the questionnaire were mailed to contacts who had not responded after four months of contacting them electronically.

SURVEY QUESTIONS

The questionnaire asks for demographic information and includes questions about variables thought to influence attrition, including perception of mentorship, feelings of isolation, the imposter syndrome, and self-perception about potential to develop into good researchers or teachers. Because of space constraints, results for only some of these measures are presented in this paper.

Demographic Variables and Measures of Future Plans

Demographic variables include questions about gender, year of birth, number of years in program, part-time vs. full-time student classification, citizenship status, source of graduate school funding, field of bachelor's degree, educational goals, primary research methods, and career plans.

Mentorship and Feeling Welcome Measures

Students were asked if they felt they were being mentored. The answer options were “yes” and “no.” The question did not ask for information about who was mentoring them. For feeling welcome, students were asked to rate on a five-point scale—ranging from strongly agree to strongly disagree—their agreement with this statement: “I find the overall environment in my department to be welcoming.” This measure has been used with success on several surveys of physics students conducted by the SRC.

Self-perception Measures

Imposter Syndrome Measures

Questions adapted from the Clance Imposter Scale (1988) and Harvey Imposter Scale (1981) were used to measure the imposter syndrome among astronomy graduate students. The questions were modified for use with astronomy students. Using a five-point scale, students were asked to rate the level to which they agreed with the statements below. The tendency to agree with items one through four below is indicative of the imposter syndrome. The tendency to disagree with items five through seven below also is indicative of the imposter syndrome.

1. *In general, people tend to believe I am more competent than I really am.*
2. *Sometimes, I am afraid others will discover how much knowledge or ability I lack.*
3. *At times, I feel I am in my current career position through some kind of mistake.*
4. *When I succeed, it is because I work much harder than others.*
5. *The major cause of success in my life is my high ability.*
6. *I feel highly confident that I will succeed in my future career.*
7. *I am at least as smart as my peers.*

Additional Self-Perception Measures

To measure students' perceptions of their academic ability, they were asked to rate—again on a five-point scale—their level of agreement with statements about their ability to develop into good researchers and teachers. The tendency to agree with these items is indicative of positive self-perception.

1. *Overall, I have the skills to develop into a good researcher.*
2. *I generally have the skills to develop into a good teacher.*
3. *I have adequate access to facilities/equipment to develop into a good researcher.*

HYPOTHESES AND METHODOLOGY

Because of the history of the study, most of the hypotheses focused on gender differences. The working group hypothesized that the imposter syndrome would be more likely to occur among women than among men. Women are underrepresented in astronomy, so we thought that this could contribute to a feeling of not belonging in the field. The working group thought the imposter syndrome might also be explained by: feeling mentored in graduate school, length of time in graduate school, type of support in graduate school, citizenship, and full-time vs. part-time status in graduate school.

We also hypothesized that these same variables would predict who felt mentored in graduate school, who felt welcome, and self-perceptions about the potential to be good

researchers and teachers. If gender differences in our dependent variables exist, we wanted to make sure that they exist independently of the possible effects of other independent variables, so we tested our hypotheses using multivariate models.

Logit analyses were used to examine whether feeling mentored, number of years in program, part-time status, type of support for graduate studies, citizenship status, and gender affected feeling welcome in a department, self-perception of research and teaching skills, and responses to imposter syndrome measures. We also tested these same independent variables effect on students' belief that they were being mentored.

In all, we ran 12 different logit models, one for each of the seven imposter syndrome measures, one for each of the three measures of self-perception, one for feeling welcome in the department, and one for feeling mentored.

RESULTS

Due to space constraints, only the results relating to mentorship, length of time in program, and gender will be discussed in this paper. Other results will be published at <http://www.aip.org/statistics>.

Responses

We received 1,576 responses to the survey. Of that number 1,348 respondents identified themselves as graduate students in astronomy or astrophysics. Of these 1,143 identified themselves as male or female and were therefore included in the analysis.

Demographics

Approximately forty percent of the respondents identified themselves as women. Most of the respondents' parents have college degrees. The majority of the respondents were U.S. citizens. Twenty-three percent of the respondents reported having temporary student visas (Table 1).

Table 1. Demographics

Variable Description	Frequency
Female	39%
Mothers have college degrees	64%
Fathers have college degrees	71%
U.S. Citizen	77%
Planning to obtain a PhD	91%
Full-Time status	97%
Median Age	27 years
Median Length of Time in Program	3 years
# Analyzable responses	1,143

Feelings of mentorship are linked to positive outcomes. Students who reported feeling mentored were more likely than others to report feeling welcome in their department, more likely to report believing that they have the skills to develop into good researchers and more likely to report having access to facilities and equipment that would help them develop into good researchers. These effects are particularly strong (Table 2). Moreover, students who reported feeling mentored appear to be less likely to exhibit characteristics of the imposter syndrome. Mentored students were more likely to report that the major cause of success in their life was due to high ability and that they are at least as smart as their peers. Students who reported feeling mentored were also less likely to report that they felt they were in their current career position through some kind of mistake (Table 3).

Length of time in program, part-time/full-time status, and citizenship status were significant predictors of whether or not a student felt mentored. The longer a student was in a program, the less likely they were to report feelings of being mentored. The effect in the table shows how much the odds of feeling mentored decrease for each additional year spent in the program (Table 4).

Table 2. Logit Analysis Odds Ratios for Selected Variables¹

Independent Variables	Dependent Variables			
	Environment is welcoming	Have skills to develop into a good researcher	Have skills to develop into a good teacher	Access to facilities and equipment
Feeling mentored	4.04**	2.39**	1.16	4.19**
# of years in program	0.96	0.89*	1.01	1.01
Part-time student	0.63	0.43	1.55	0.91
Research assistantship²	1.21	1.21	0.56*	2.44**
Fellowship²	0.86	1.58	0.82	1.82
Other \$ support^{2,3}	1.79	1.68	0.68	0.95
Temporary visa	1.13	0.99	0.58**	0.67
Sex: female	0.61**	0.82	0.78	0.83

**p<.01

*p<.05

¹A result <1 indicates that the respondents who fall into the defined group are less likely to agree with the statement than their counterparts, while a result >1 indicates that they are more likely to agree with the statement.

²Teaching Assistantship is the comparison group.

³Other financial support includes family, savings, loans, and tuition reimbursement from outside employment, students' income from outside employment, foreign government support, and military assistance. Teaching assistantship is the comparison group.

Table 3. Logit Analysis Odds Ratios for Imposter Syndrome Variables¹

Independent Variables	Dependent Variables						
	People believe I am more competent than I really am.	Others discover I lack ability or knowledge.	Succeed in my future career.	In my current career by mistake.	The major cause of success in my life is my high ability.	I work much harder than others.	I believe I am at least as smart as my peers.
Feeling mentored	0.86	0.81	1.68**	.50**	1.18	.88	1.34*
# of years in program	0.99	1.04	0.83**	1.06	0.95	1.0	0.97
Part-time student	1.21	1.20	2.03	0.67	0.77	1.75	1.16
Research Assistantship²	1.08	1.02	1.03	1.24	1.08	1.03	1.21
Fellowship²	0.86	0.89	1.01	1.26	1.04	1.27	1.14
Other financial support^{2,3}	0.40*	0.52*	2.18*	0.61	1.13	0.78	2.44*
Temporary visa	0.83	0.38**	0.65**	0.89	1.08	1.59**	1.49*
Sex: female	0.92	1.60**	0.64**	1.16	0.76*	1.27	0.83

**p<.01

*p<.05

¹A result <1 indicates that the respondents who fall into the defined group are less likely to agree with the statement than their counterparts, while a result >1 indicates that they are more likely to agree with the statement.

²Teaching Assistantship is the comparison group.

³Other financial support includes family, savings, loans, tuition reimbursement from outside employment, students' income from outside employment, foreign government support, and military assistance. Teaching assistantship is the comparison group.

Table 4. Logit Analysis Odds Ratios with Mentorship as the Dependent Variable¹

Independent variables	Dependent Variable
	Feeling Mentored
Number of years in program	0.88**
Part-time student status	0.44*
Research Assistantship ²	1.26
Fellowship ²	1.26
Other financial support ^{2,3}	1.26
Temporary visa	1.41*
Sex: Female	0.95

**p<.01

*p<.05

¹A result <1 indicates that the respondents who fall into the defined group are less likely to agree with the statement than their counterparts, while a result >1 indicates that they are more likely to agree with the statement.

²Teaching Assistantship is the comparison group.

³Other financial support includes family, savings, loans, tuition reimbursement from outside employment, students' income from outside employment, foreign government support, and military assistance. Teaching assistantship is the comparison group.

Gender and Length of Time in Program Also Matter

Female astronomy graduate students appear more likely than males to show characteristics associated with the imposter syndrome. Female astronomy graduate students were less likely than males to report that the climate in their department was welcoming (Table 2), and they were more likely than males to say that they were afraid others would discover how much knowledge or ability they lack (Table 3). Women were also less likely to attribute their success to high ability and less likely to report feeling confident in their ability to succeed in their future careers (Table 3). Furthermore, women may be more likely than men to report feeling that they had to work much harder than others to succeed (Table 3, $0.05 < p < 0.10$).

The longer students stay in graduate school, they become more likely to doubt their ability to develop into good researchers (Table 2), more likely to doubt that they will succeed in their future careers (Table 3), and less likely to feel mentored (Table 4). It should not be assumed that these effects pertain only to graduate students who have been in their programs “too long.” Rather, our analyses show these effects start after only one year of graduate school. The mechanism by which length of time in graduate school affects likelihood of being mentored is not clear because the question measured perceptions of being mentored, but did not ask students by whom they felt mentored. It could be that

more advanced students are less likely to be mentored by faculty. On the other hand, it could be that beginning students are mentored by more advanced students and that this naturally tapers off with time.

CONCLUSION

The working team hypothesized that female graduate students in astronomy would be more likely to feel like imposters, not feel mentored or welcome in their programs, and have less positive self-perceptions of their ability to become “good” astronomers. The results of this study found that female astronomy graduate students are more likely than males to exhibit traits consistent with the imposter syndrome. This may be, in part, a result of female graduate students not feeling as welcome in astronomy departments as male graduate students. We also found that the longer a student stays in graduate school, the more likely they are to demonstrate one indicator of the imposter syndrome and the less likely they are to feel mentored. Mentoring improves a graduate student’s situation, because these students are much more likely to feel welcome and have the positive perception that they can develop into good researchers. Mentored students are also less likely to exhibit the imposter syndrome.

Overall, the results suggest that special efforts should be made to ensure that as students move further along in their studies, they are effectively mentored. While graduate schools have an incentive to move students up and out of their programs, it goes without saying that motivating students to finish need not entail making them feel like they will not succeed in their future careers. More positive support should be given, including assurances about their future as astronomers. Additional efforts should be made to create a welcoming and inclusive environment for both sexes. The effects will be to create a stronger, more diverse, and more confident astronomy workforce.

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Gender Differences at Critical Transitions in the Careers of Science, Engineering and Mathematics Faculty

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In June 2009, the National Research Council released a study entitled *Gender Differences at Critical Transitions in the Careers of Science, Engineering and Mathematics Faculty*.¹ I had the honor of serving together with Dr. Sally Shaywitz from Yale as the co-chairs of the committee² that conducted the study; the final edited publication will be available early in 2010. This paper is a brief overview of some of our key findings along with a few personal remarks.

Our study, which began in 2004, was mandated in Congressional language following hearings held by Senator Ron Wyden on the application of Title IX (which bars discrimination by recipients of federal funds) to science and engineering faculty. The hearings had been sparked in part by the Women in Science study at MIT led by Nancy Hopkins in the latter 1990s, and by subsequent reviews at many other universities, which revealed possible discriminatory treatment of women faculty. The charge of our committee was to focus on issues such as faculty hiring, promotion and tenure, as well as the allocation of resources such as laboratory space. The NSF was directed to fund the study.

Our committee decided that the only way we could satisfy the charge was by conducting original research—the data we needed were simply not available. We also chose to focus our investigation on the 89 major research universities (the so-called Carnegie Research I category), which produce the vast majority of PhDs who then become faculty at other universities in the future. We then surveyed the 500 departments and 1,800 selected tenured or tenure-track faculty in six disciplines: biology, chemistry, civil engineering, electrical engineering, mathematics, and physics. The surveys provide a snapshot of the 2004/2005 academic years. We also made extensive use of the literature, including the NSF's several periodic studies of academic workforce.

¹*Gender Differences at Critical Transitions in the Careers of Science, Engineering and Mathematics Faculty*, 2009, National Research Council; National Academies Press, www.nap.edu

²Committee on Gender Differences in Careers of Science, Engineering, and Mathematics Faculty, C. Canizares & S. Shaywitz (co-chairs); L. Abriola, J. Buikstra, A. Carriquiry, R. Ehrenberg, J. Girgus, A. Leibowitz, T. Tylor, L. Wu; NRC Staff: C. Didion, J. Sislin, P. Henderson, J. Ham

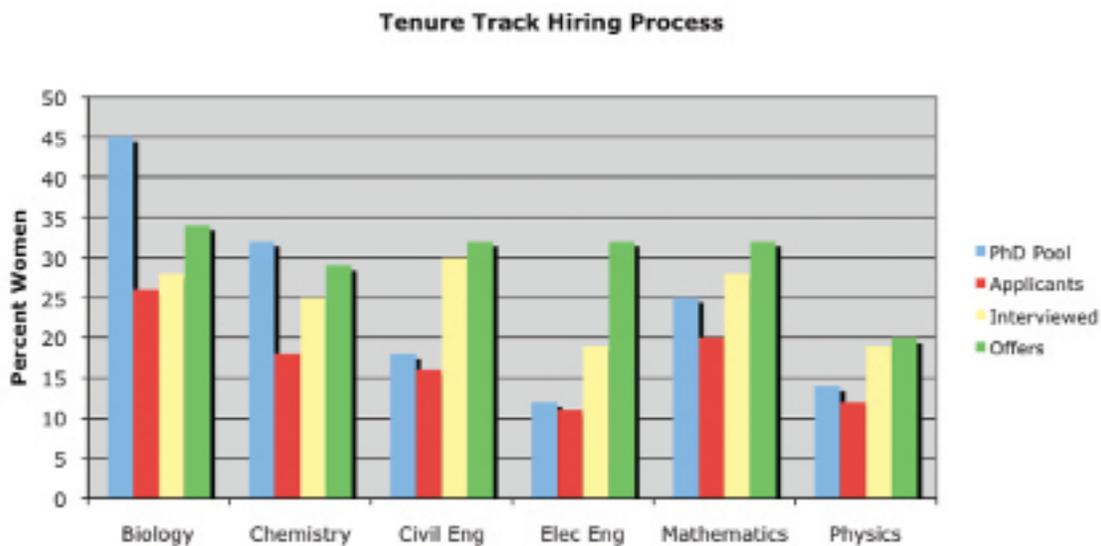


Figure 1.

In terms of overall representation, we found that the fraction of women among Science & Engineering (S&E) faculty continues to increase (data from NSF's Survey of Doctoral Recipients). But the increase is slow and women are still under-represented—sometimes severely so. The rate of growth is largest in disciplines with the lowest representation, such as physics and engineering. For example, in both physics and engineering, there has been a doubling over eight years (1995-2003) in the fraction of women at the associate and full professor levels (in physics in 2003, women were 24%, 19% and 8% of physics assistant, associate and full professors, respectively). Unfortunately, the fraction of women assistant professors appears to be flat or, at best, slowly increasing over the same eight-year period.

The primary objective of our study was to examine the critical career transitions, so our departmental and faculty surveys contained questions about hiring, promotion and resources. We found, often to our surprise, that there is little or no evidence for gender imbalances at these transitions, and even some indication of more positive outcomes for women. Before giving the details, I want to stress that this certainly does NOT mean that gender discrimination is at an end. But it does mean that, on average, our snapshot shows that institutions are attempting to control the factors that govern critical career transitions in ways that achieve a greater degree of gender equity.

The start of the formal journey through academia is the hiring of an assistant professor. Figure 1 shows the fraction of women among applicants, interviewees, and those that received the first offer for our six disciplines. Interestingly enough we found that the proportion of women invited to interview was actually higher in all our fields than their

fraction in the applicant pool and the proportion who received their first job offer was higher than the proportion that interviewed. In fields such as Electrical Engineering, where women are least represented, the difference is greatest. Some might attribute this to a kind of “affirmative action.” It could well be due in part to a “natural selection” by this stage of career, in which women who persist, particularly in fields with low representation, may be stronger candidates on average.

One of our most interesting (and troubling) findings is that in each of the six disciplines we surveyed, the proportion of women applicants was lower than the percentage of PhDs awarded to women. This is also shown in Figure 1, where the first bar is the fraction of women in the PhD pool from the previous four years. The biggest discrepancies occur in the fields that have the largest representation of women among PhDs. In biology where 45% of the PhDs go to women there are only 25% women in the applicant pool. Chemistry has 32% women among PhDs but 18% among applicants. Even in electrical engineering and physics, where the differences are smaller, the sign is the same.

We asked departments about strategies that they used to bring women into the pool, but no particular strategy stood out. There was some positive effect from having women on the search committee and women chairing the search committee. Surprisingly, two-thirds of the departments reported that they took either no steps or only one single step to increase the gender diversity of their applicant pools.

What we learned about resources and other aspects of the professional experience of men and women faculty was more heartening. Nancy Hopkins’ study at MIT in the mid 1990’s, which was repeated at a large number of universities, found significant measures of non-inclusion, if not discrimination, among women faculty (<http://web.mit.edu/faculty/reports/sos.pdf>). We did not find such evidence at the time we did our studies. One thing, for example, found in the earlier studies was that women tended to get assigned more teaching duties, which might have a negative effect on their research. We found no significant difference. Overall, men and women appear to spend equal amounts of time on the various tasks of being a faculty member. Similarly, we found no gender differences in terms of access to the resources generally provided by a department chair, such as start-up packages. And once we corrected for time in rank, there was no difference in the amount of lab space; one of the notable areas of gender discrepancy in the Hopkins report.

There were a few areas of gender difference. Women were more likely to report having departmental mentors: 57% of the women vs. 49% of men (I find both numbers woefully low). Women were less likely to engage in conversation on some

professional issues, but by most of the other measures there was no statistically significant difference. Women and men had very comparable outcomes such as honors and awards, belonging to a research team and chairing committees. They also had comparable probability of having grant funding, although female assistant professors with mentors had a much higher probability of having a grant than those without a mentor (93% vs. 68%). Surprisingly enough, mentoring had the opposite effect on men (though smaller: 83% vs. 86%). I might speculate whether women might be assigned mentors more routinely whereas men are more likely assigned mentors when they are in difficulty?

The next major transition is the all-important promotion to tenure, and here again the findings regarding probability of promotion are heartening. We found that women were tenured at a slightly higher rate than men (an overall average of 92% for women and 87% for men).

We also found that so-called “clock stopping” policies (which allow a year or two delay in the timing of a tenure decision for childbirth or sometimes adoption) did not affect the likelihood of a positive tenure outcome. Not surprisingly, those who stopped the clock took on average 1.5 years longer to achieve tenure. The increase in usage is also apparent in our data: clock stopping was used by 19.7% of women and 7.4% of men assistant professors, whereas the percentages were 10.2% and 6.4% for current associate professors.

However, as in the case of the initial hiring, we found again that the proportion of women coming up for tenure was smaller than the proportion of female assistant professors. Again, the discrepancies are largest in biology and chemistry, the two fields with the most women. Our report takes a balanced view in noting that this could be either evidence of a “leaky pipeline” (in which women are more likely to leave academia prior to the tenure decision) or an artifact of an increased rate of assistant professor hiring in previous years. My own view is that the data, at least for biology, shows that the percentage of women assistant professors has been nearly constant at 36% over the previous eight years, whereas the percentage considered for tenure is 27%. So in biology women are more likely than men to leave academia sometime prior to tenure.

For the final step, promotion to full professor, we found no gender disparities. Furthermore, women were proposed for promotion to full professor at the same proportion as their representation among associate professors. In other words, there was no evidence for continued higher “leakage” from the academic pipeline following tenure.

For me, a very interesting finding is that time to tenure for both men and women has increased significantly in nearly all fields. Unfortunately, we can only see this somewhat indirectly in our data by comparing the time between the award of a PhD and tenure promotion for current full professors vs. current associate professors. Of course, the full professors were promoted some years earlier, compared to current associate professors, albeit with a wide dispersion. The table below shows the difference between the time of PhD to tenure for current full professors and current associate professors in years. With the exception of male mathematicians and female electrical engineers, the times have increased, sometimes dramatically. Presumably this represents the lengthening of the postdoctoral terms that most of us know anecdotally. We did not collect data on the time to PhD.

<u>Discipline</u>	<u>Men</u>	<u>Women</u>
Biology	4.7	1.1
Chemistry	1.4	3.3
Civil Eng	4.9	1.0
Elec Eng	2.7	-0.7
Math	-1.2	1.1
Physics	2.4	0.8

Table shows time (yrs) between PhD and tenure
for current Assoc Prof minus that for current Full Prof

I have presented what I consider to be the most salient findings in our report, but there is more detail in the full volume. I will not review our recommendations except to note the clear need for more routine data collection and especially for longitudinal studies, to help us really understand the career trajectories of both male and female faculty. We very much hope that the NSF can foster additional work in this area. There are also some obvious lessons for departments around retention of women faculty, increased mentoring and working harder to bring women PhDs onto the faculty track.

My personal view is that our study does indeed contain a lot of very good news for all of us who have been working to increase the representation of women among STEM faculty. In the '90s it was shown that institutions, whether intentionally or more likely through a whole set of unintentional factors, were simply not treating women equally to men. Our study suggests that this situation has improved significantly. Is discrimination dead? By no means! We all know far too many specific stories to the contrary. But on average we're doing a lot better than we were. In particular, academic departments (and Deans, Provosts and Presidents) are on-average working to control those factors that govern the critical transitions in a faculty career.

But we still have a long way to go. One thing that's clear to me is that if departments are indeed doing better at controlling the factors that govern transitions and yet we are still not solving the problem then the remaining impediments must be deeper and more systemic. For one thing, there is evidence that the system has "friction:" history has shown that sporadic increases in the representation of women due to proactive measures often stagnate rather than continuing.

Going beyond the report itself, my own personal concern is that the current nature of the profession may itself be a significant part of the problem. I worry that there are structural aspects of the academic profession that are unattractive to both men and women; it's just that these factors are differentially more unattractive to women than to men. What we can detect in our data is the differential effect. Only longitudinal studies will tell us if, as I suspect, we are losing both men and women of great promise and talent from the professorial pool. I would also suggest that the increasing time to tenure might be a prime factor in this unattractiveness. If we now expect in many disciplines that an assistant professor candidate have spent six plus years as a postdoc, followed by roughly six more years before tenure, then a typical faculty member will be approaching the age of 40 before he or she achieves long-term stability, or even knows which part of the country will be home to her or his family. Of course, that timing is particularly problematic for women (and men with working spouses) who want children, which may contribute to the differentially increased unattractiveness that seems to emerge from the data. I would also suggest that these factors might appear differentially more unattractive to under-represented minorities as well, which could thwart efforts to increase diversity. We all know of the great many factors that make academic careers highly satisfying and rewarding, but have we made the price of entry too high? And in doing so, are we really achieving the highest quality, not to mention the equity, which we strive for.

Like any successful research project, our study provides some answers but also raises new questions. We should be encouraged by the good news we found in this study, but by no means should it make us complacent. The truth is that we still have a long way to go before we are anywhere close to gender equity in terms of representation. If, as I suggest, the remaining factors are deeper and more systemic, it will not be easy to address them. I do hope that universities, professional societies and government agencies will continue working to identify those factors and then to attack them. Of the US population, only roughly one-third are white males, and that fraction is declining. Disadvantaging or discouraging the other two thirds who are female and under-represented minorities from pursuing academic careers is no way to run a talent search. The health of our universities, and therefore of our workforce and our economy, depends on getting this right.



CATHERINE CESARSKY

High Commissioner for Atomic Energy, France

Women in Astronomy: IAU Statistics

Catherine Cesarsky, High Commissioner for Atomic Energy, France

SUMMARY

Statistics have been gathered from countries around the world and compared to International Astronomical Union (IAU) figures. Almost no country has an equal percentage of women in the IAU as it does in its population of astronomers, and the gender advantage is always in favor of men. As scientists, gathering statistics helps us understand the situation and encourages attempts to improve it.

INTRODUCTION

When asked to present a paper on international statistics about women in astronomy, I thought: “How can I do this?” I knew that, despite the efforts of the IAU Working Group on Women in Astronomy and of the International Year of Astronomy (IYA2009) Cornerstone Project “*She is an Astronomer*,” there are few statistics gathered in a consistent fashion. But I decided to rise to the challenge by writing letters to people at various institutions and obtain some numbers and curves. These are now displayed and commented on in this paper. The data are inhomogeneous, but allows for some interesting remarks, and perhaps this study will foster more rigorous ones in the future.

The IAU is an international organization with sixty-eight countries as national members, so its membership and its variation with time is a good set of data to use as comparison with figures from individual countries. In many countries, to become a member of the IAU, the person must have obtained some level of recognition. Thus, at the start, I made the assumption that, if in a country women have difficulties in recognition, retention, and promotion, they will be at a higher percentage in the population of astronomers than of the IAU; the ratio of the two percentages is then an indicator of discrimination, glass ceiling or any other impediment for women to strive in their careers.

IAU STATISTICS

Some numbers are easy to get, since we have just had a General Assembly of the IAU in Rio de Janeiro in August 2009. The Local Organizing Committee (thanks to Norma Tavares) counted 667 women in the 2109 people attending the IAU, so this gives us 31.6% of the people attending the IAU were women. We know very few sessions had 31.6% of their talks given by women and only one of the ten plenary reviews and invited discourses was given by a woman (10%). Every three years the IAU has new members elected, and in 2009 the total number of members exceeded 10,000 members. The number of women is increasing—in 2003 it was 12.1%, in 2006 it rose to 12.9%, and it now stands at 13.6%, an

increase of 0.7% per triennium. So the percentage of invited speakers at the IAU reflects the percentage of female members in the IAU.

Table 1, taken from the website of the IAU Working Group on Women, shows the percentage of female members of the IAU per country; I have only selected countries which have more than 40 members. Argentina, at 35.8%, has by far the highest percentage of women. Only six of these countries have more than 20% female members in the IAU: Ukraine, Italy, Bulgaria, France, Brazil and Hungary. The USA is at 12%, and since they encompass a high percentage of the IAU population, they carry most weight in the IAU total average. Seven countries are below 10%: in decreasing order: Denmark, Switzerland, Germany, China Taipei, Israel, India and Japan.

Table 1. Percentages of women in the IAU in 2009	Country	#members	%total	%women
	Argentina	134	1.3	35.8
	Ukraine	188	1.9	27.1
	Italy	568	5.6	24.7
	Bulgaria	57	0.6	24.6
	France	700	6.9	24.3
	Portugal	43	0.4	23.3
	Brazil	172	1.7	22.7
	Hungary	48	0.5	20.8
	Ireland	44	0.4	20.5
	Austria	49	0.5	18.4
	Spain	303	3.0	17.8
	Mexico	111	1.1	17.1
	Russian Fed	368	3.6	17.1
	Finland	67	0.7	16.4
	Greece	108	1.1	15.7
	Chile	90	0.9	15.6
	China (Nanjing)	409	4.0	15.4
	Belgium	117	1.2	15.4
	Australia	262	2.6	15.3
	South Africa	71	0.7	14.1
	Sweden	111	1.1	13.5
	Poland	149	1.5	13.4
	Czech Rep	92	0.9	12.0
	Canada	245	2.4	12.2
	USA	2594	25.5	12.1
	UK	524	5.2	11.6
	Netherlands	208	2.1	11.5
	Egypt	56	0.6	10.7
	Korea	109	1.1	10.1
	Denmark	63	0.6	9.5
	Germany	532	5.2	9.4
	Switzerland	76	0.8	9.2
	Israel	75	0.7	8.0
	China (Taipei)	51	0.5	7.8
	India	222	2.2	7.7
	Japan	598	5.9	5.5

ASIA

The lowest percentages of women are found in Asia, so I looked into this in some detail. According to the IAU membership in 2009, 5.5% of Japanese members were women (33). Yuko Motizuki sent me more up-to-date statistics showing that the total population of women in astronomy, including post-doctoral researchers, is 12%, out of the 1500 members of the Astronomical Society of Japan. The number of women has risen from zero in the early 1960s, with a steep increase in the last decade, so this is a situation that is changing rapidly; of course it means that most women are young and it will take them some time to become eligible for IAU memberships. The other Asian country to supply information (through Yanchung Liang) is Nanjing, China (see Table 2). In 2009 Nanjing had 15.4% female membership in the IAU, significantly higher numbers than in 2006 (12.4%).

Table 2. Statistics of Women in Astronomy in China Nanjing

Organization	Women/Total	Percentage
Members of Chinese Astronomical Society	422/2131	19.8
Members of Beijing Astronomical Society for NAO (National Astronomical Observatories, Chinese Academy of Science)	95/312	30.4
NAOC staff with permanent position	84/300	28.0
NAOC staff with contract	60/155	38.7
Peking University, Dept. of Astronomy + Kalvi Institute for Astronomy & Astrophysics	3/15	20.0
Beijing Normal University, Dept. of Astronomy	8/40	20.0
Nanjing University, Dept. of Astronomy	2/20	10.0

Here we clearly see selection effects with the comparison between populations of astronomers and the percentage in the IAU. A higher percentage of women are on contracts in the National Astronomical Observatories, Chinese Academy of Sciences (NAO-CAS) than have permanent positions, showing women have the more exposed jobs. Yanchun Liang reports that women in China are found at every level, but the ratio is lower at the highest level. For example, there are seven women among the seventy professors (10%) in the NAO-CAS and currently none of the five vice-directors is female. However the director of the Nanjing Institute of Astronomical Optics and Technology (NIAOT) is female (Prof. Xiaoqun Cui) and the director of the Urumqi Observatory of NAO-CAS is also female (Prof. Na Wang). The most famous female astronomer in China, Prof. Shuhua Ye, is a CAS academician. The picture is improving.

LATIN AMERICA

Women astronomers seem to be doing comparatively well in Latin America. In Argentina, 36.7% of the IAU members are female (in 2009). This figure compares well with the percentage of the 175 tenured researchers and professors (34.9%). The male-female ratio of graduate students and young researchers is 50-50. At the most senior level, with the distinguished and emeritus researchers, two out of fourteen are female (14.2%).

Gloria Dubner reported these figures—she has recently been appointed director of her institute, a very important institute in Buenos Aires, in which the percentage of women is 50%. Marta Rovira is the President of the Argentina National Council of Scientific and Technological Research (CONICET), and she is now a Vice President of the IAU. There has been an important advance in CONICET recently; the maximum age limit for access to fellowships and permanent positions has been relaxed for women whose careers were put on hold because of maternity (everything, of course, is based on the quality of the applicants).

Venezuela has a small number of members in the IAU (19 members in 2009) but 26% is female, and although the numbers are small, this shows a similar high percentage for researchers and professors with fifteen men and seven women (32%), and doctorate and masters' students (nine men and six women, making 40% female). In Mexico, in 2006, it was 17.5% women in the IAU, which compares with 20% of tenured researchers and 20% non-tenured posts (short-term contracts and post-docs) being female. There is a much higher percentage of women amongst the students (doctorate and master's) of 39%, showing the field is expanding. When everyone is included, the percentage of women in astronomy in Mexico is 28.3%. Numbers were difficult to obtain for Brazil, but the IAU members are 22.3 % female in 2009, and the membership of the Sociedade Astronomica Brasileira, with 479 members, is 25% female.

EUROPE

The European Commission has been very active in the last ten years, with an enormous effort to bring women into scientific careers—similar to what is happening in the USA. There was the Helsinki conference in 1998 and the European Union (EU) Action Plan in 1999 “Women in Sciences,” and the Action Plan in 2001 “Science & Society.” The Helsinki group has remained in place to monitor progress and build synergies. There is now a 40% female representation in EU programs. In 2005, a set of rules for hiring was created, paying a lot of attention to flexible working conditions, childcare support, and gender-balanced representation at all levels. Special groups have been set up, such as Women in Industrial Research (WIR) and European Platform of Women Scientists (EPWS). The SHE group gathered statistics between 2003 and 2006. Twenty-nine percent of all scientists throughout Europe are women.

In the rest of this section, I use statistics gathered for “sciences of the universe,” which is roughly astronomy and Earth sciences. Although the percentages vary from country to country, there are some persistent patterns. Strangely, when compared to European politics, and women are well represented in the European parliament, it appears that in countries where there are a lot of female astronomers, there are few female politicians and vice versa.

The EU uses a number called the Gender Advantage, using scientists at levels from post-doc to the most senior levels, and this shows how much more work is needed in Europe (see Table 3).

Gender Advantage = $\frac{(\% \text{ men at top level relative to men at all levels})}{(\% \text{ women at top level relative to women at all levels})}$

If the Gender Advantage is > 1 , it shows women are not promoted as often as men.

Gender Advantage	Country
1.0 to 1.2	Belgium, Italy, Sweden
1.3 to 1.5	France
1.6 to 1.8	Denmark, Norway
1.9 to 2.1	Austria, Finland, Germany, Netherlands, UK
2.4	Switzerland

Table 3. Gender Advantage ratios in Europe

Danielle Alloin gave me the figures for France (the IAU membership is 24.3% female), using the “sciences of the universe” figures. For the last twenty years the situation has been stable with 26% of the scientists at CNRS being female, and astronomers are a significant part of CNRS. However, at the most senior levels the number is 21% female, as is the figure for the mid-level. The Gender Advantage at the mid- and junior level is 1.5. Only 10% of laboratory heads are female, but women do make up 24% of the hiring/evaluation committees. In French universities 16% of the professors are female (compared to the EU mean of 11%) and women make up 38% of the mid-level and junior grades (compared to the EU mean of 30%). The recognition of women’s work in this field in France is low, with none of the six CNRS gold medals awarded to women (in fifty years), 14% of the silver medals (in six years) and 25% of the bronze medals (in six years). In the French Academy of Sciences, only 10% of the members in this section are female.

Spain has 17.8% female membership in the IAU, and although statistics were hard to find, SHE figures for 2006 for sciences of the universe and biology give 25% female—not a bad number. The situation has been changing in Italy, which now has 24.7% female membership in the IAU. In 2002 the percentage of women in astronomy was 18.5%, in 2005 it was 24%, and in 2007 it was 27%. The Istituto Nazionale di Astro-

fisica (INAF), according to Ginevra Trinchieri, has two women out of five members on the executive board (40%), five women out of twelve members of the scientific council (42%), and three women out of nineteen institute directors (16%). The major problem is that 40% of the people on soft money are female. The percentages over the years (Table 4) are difficult to compare because in 2005 there was a merger of observatories with CNR institutes and in 2007 there was a major “job requalification,” where for example the number of women at the most senior level almost doubled (from seven to thirteen), and the next level dropped from 31 to 28. The percentages for universities in 2007 refer only to astrophysical science.

The Russian Federation has about 17.1% female membership of the IAU, but no female astronomers in the National Academy of Science, while the community could be almost 40% female.

The situation in the United Kingdom, which has 11.6% female membership in the IAU, is bad. The sciences of the universe figures show the percentage of female astronomers drops from 22% at the junior levels (starting post-doc) to 12% at mid-level, 10% of lecturers and 4% of professors. No laboratory heads are female. According to Helen Walker of the Science and Technology Facilities Council Rutherford Appleton Laboratory, these numbers are very similar to the figures produced by the Royal Astronomical Society. Francesca Primas looked at European Southern Observatory faculty members in 2005, and found that although 18.7% of the staff was female, only around 3.4% of the top level staff were women, and around 16% of the mid-level. The gender advantage ranged from 6.4 to 1.2. These numbers are not good, and efforts have been made to improve them.

Scientific staff	2002	2005	2007	2007(University)
Senior	10.9	11.3	19.1	~4
Associate	15.7	19.3	17.5	~6
Researcher	20.6	28.2	32.6	~22

Table 4. Percentages of female staff at INAF

CONCLUSION

Gathering statistics over a period of many years is very important. The reader can see from some of the numbers, a snapshot does not give enough information. Almost no country has an equal percentage of women in the IAU as it does in its population of astronomers, so we could say the Gender Advantage is always in favor of men. Gathering statistics helps us, as scientists, understand the situation and make attempts to improve it. One such example is the resolution approved by the International Astronomical Union at its recent general assembly meeting, urging astronomers to support and encourage the female astronomers in their community to break down barriers and ensure that men and women are given equal opportunities.

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ABIGAIL STEWART

University of Michigan

Addressing Unconscious Bias

Abigail Stewart, University of Michigan

It is an honor and pleasure to be here. For a long time I have been an admirer of the way women astronomers and their male allies have put the issue of inclusion on the table in your discipline. Moreover, you have kept it there and rethought it very consistently. I do believe that psychologists may have something to contribute to the conversation about inclusion and the role of unconscious bias as a barrier to it. I will begin by defining what psychologists mean by unconscious bias. Then I will talk about when it matters and what we can do about it, and whether what we can do about it really changes anything.

WHAT IS UNCONSCIOUS BIAS?

The social science literature on inclusion depends on the notion of *schemas*, which can be thought of as non-conscious hypotheses, or expectations, that we have about a group of people. These hypotheses might be about people in different disciplines: social scientists or astronomers or physicists. In academia, we tend to have expectations about groups of people based on their disciplines, and those expectations can influence our judgments of particular individuals; implicitly we compare them to our expectations about the group they belong to. Expectations or schemas influence us regardless of what our own group is (Valian, 1998). For example, you know what the stereotype of astronomers and physicist is, even if you are a member of that group, just as I know what your stereotype of a social scientist is! We live in the same culture; we understand each other's schemas, so in effect our schemas are very widely shared (Fiske, 2002). And they influence not only our expectations of others, but also our expectations about how we will be judged (Steele, 1997). Of course the schemas that we are most interested in talking about here are the schemas about gender; these include the expectation that men are strong, task-oriented and have leadership qualities, while women are kind, care about others, and pay attention to emotions. These schemas about gender—like those about race and ethnicity—complicate our efforts to be more inclusive.

Although that is true, we must recognize that schemas are functional (Valian, 1998); they allow efficient processing of information. For example, if you have a message that you want to convey to a teacher in a classroom, and you look around the room, you will be very likely to choose the person in the room who is the oldest. Your schema for “teacher” is a stereotype, but it is also often true that the teacher is older than the students, and if you rely on it you will be likely to get the message to the teacher successfully. So we use schemas because they often work, even though they are sometimes inaccurate.

Schemas often conflict with conscious attitudes, which is surprising and sometimes confusing to people (Nosek, Banaji & Greenwald, 2002). People who hold inclusive conscious attitudes—for example, that women are just as likely to be good scientists as men—can also have unconscious or implicit bias in their expectations. Nevertheless, our schemas, even our implicit biases, can change (Bauer & Baltes, 2002). If we have more information that lets us know that the culture-based schema is not true, we are much less likely even to retain the implicit bias (Gawronski & LeBel, 2008). So I do want to acknowledge that there is room for even implicit biases to change; they just change slowly because they are out of awareness and heavily influenced by cultural consensus.

Schemas obviously affect our judgments of people, but not all the time and under all circumstances. If we know that a particular woman is a terrific scientist, we accept that fact. But we do not usually think of any given exception as challenging our schema. Instead, we think of the person as an exception to a schema that still generally works. Therefore, we apply our schemas when we do not know much about an individual—when we think of that person mainly as an exemplar of a group (women) about which we have an expectation. We are also likely to apply schemas when we have to form an opinion despite stress from competing tasks or time pressure, and when we have been exposed to few exemplars of the category in question. If you think about this in the context of a search committee, you can imagine a search in which three candidates come in for an interview, one of which is an African-American woman. You can just think of her as “the African-American woman,” which is not likely to be the way you will think of any of the “white men.” When there are many people in a category, we know that category is not an adequate or informative descriptor. But thinking about an individual in terms of the groups to which she belongs increases the likelihood that our schemas about those groups influence how we think about her.

The important point is that schemas influence our judgments most under particular conditions; when we are evaluating an individual who belongs to a demographic group about whom we have a schema that conflicts with the quality we are attempting to assess. Many studies have examined these processes in terms of gender, race and sexual orientation. All of these studies have used similar methods or research designs, and they have examined a range of evaluative situations: auditions of orchestra players, assessment of resumes and CVs, and fellowship applications. A particularly important study showed that the adoption of audition practices that obscured gender (by having musicians audition behind a screen) greatly increased women’s hiring by major orchestras (Goldin & Rouse, 2000). Equally, a study of postdoctoral fellowship applicants found that raters evaluated male applicants much more generously than female ones—in fact women had to be two-and-a-half times

more productive than equivalent men to earn the same rating (Wenneras & Wold, 1997). These studies took place “in the field” using actual ratings. But social scientists have not often been able to assemble enough cases to analyze data of this sort. Much of the literature depends on experimental simulations of ratings that are frequently made in academia and other workplaces.

The basic logic of these studies is: you take a CV, or academic record, and you put a name at the top of identical resumes that differ only by race, or gender, or sexual orientation. Thus, identical records are being judged and the only thing that is different is the cue to race, gender or sexuality. Researchers ask half of the respondents—in one case psychology professors from the American Psychological Association directory—to rate one person’s CV in terms of their qualifications for a position. Thus, they see only one CV and are asked, “What are the chances you would hire this person?” Male and female university psychology professors two-to-one preferred to hire Brian in comparison with Karen, even though they had identical credentials (Steinpreis, Anders, & Ritzke, 1999). The only difference between them was their name. This methodology has been replicated many times; it has been used with African-American sounding names and white sounding names with very similar results (Bertrand & Mullainathan, 2003). It has been used with a videotape of an instructor teaching a class who in one context refers to his partner Jason and in the other refers to his partner Jennifer (Russ, Simonds, & Hunt, 2002). Under all of those conditions you get this kind of differential result; there is no difference except a cue to sexual orientation, race or gender, but there is a biased response. The biased response is not limited to the dominant group (women, whites, etc.).

It is important to note that when raters evaluated a very experienced profile, such as that associated with a tenured faculty member with a very strong record, the cue to gender did not make a difference in the judgment. This suggests that there are limits to the operation of bias. Even so, in the study that demonstrated this, though the “bottom line” decision was unaffected by gender, raters made four times as many marginal comments expressing reservations about the female candidates as the male (Steinpreis, et al., 1999). In the “real world,” expressing those kinds of reservations, having those in the air, does have consequences for a person’s career even if the person does get the position, grant, or award they deserve.

Shelley Correll and her colleagues conducted a brilliant study that combined these two methods—experimental and field studies (Correll, Benard, & Paik, 2007). They wanted to assess the impact of schemas about motherhood, as a special case of gender schemas. They prepared identical resumes except that one applicant listed “active in the PTA” and the other did not. Evaluators rated the resumes from mothers—that is the women

who listed the PTA on their resume—as significantly less competent and committed to paid work than the non-mothers; and in the field they called them in for interviews half as often. In addition, mothers were less likely to be recommended for promotion and management, and they were offered lower starting salaries both in the laboratory and in the field. Perhaps you are not surprised by these results and suspect that this effect applies to all parents. Correll et al. carried out the parallel study of fathers and found that they were not disadvantaged in any way. In fact, they were seen as more committed to paid work and they were offered higher starting salaries. In this study, as in all of the others mentioned, I believe that people of good will were trying to hire the best person. They did not have a motive to hire less-qualified people. Nevertheless, over and over we find that gender, race, and sexual orientation biases get in the way of fair evaluations.

I mentioned that the context—how many people who are in a category are in the applicant pool—matters. This is often referred to as “critical mass.” It makes sense that when there are a lot of individuals we differentiate among them and we cannot rely on group-based schemas. In both experimental and field settings increasing the proportion of women in the field or the proportion of underrepresented minorities in the pool increases the rating of all members of those groups (Heilman, 1980; Sackett, DuBois, & Noe, 1991). So changing the ratio changes the outcome. What this means for searches is that the more diverse the pool is—the more members of underrepresented people are in it—the fairer the outcome is likely to be.

A career is filled with judgments or evaluations. Regrettably, they tend to accumulate across time, and increase the gap between men’s and women’s records—of grants and awards and of course salaries; so the gaps are much larger at late career stages than at early ones (Martell, Lane & Emrich, 1996). Virginia Valian, of Hunter College, says that women and minorities are often told not to “make mountains out of molehills,” when they complain about an unfair outcome; she argues that in fact, “mountains are molehills, piled one on top of the other” (Valian, 1999, p. 280).

Finally, it is important to recognize that schemas for different groups are not identical; the specific content of the schemas is different (Fiske, Cuddy, Glick & Xu, 2002). The particularities of each schema do need to be considered, even though some features of schemas are common across groups. Equally, the likelihood of solo status—for example, being the only member of a particular group in an applicant pool—is much higher for some groups than for others. It is quite unlikely for white women in most (but not all!) fields, but it’s quite likely for Native Americans and African Americans in many. Solo status has very particular effects both on judgment and on performance (Sekaquaptewa, Waldman, & Thompson, 2007; Thompson & Sekaquaptewa, 2002), and those effects are more likely to affect extremely underrepresented minorities, including gay and

lesbian academics. Finally, there is the question of intersecting identities. People who hold one majority and one minority identity (like African American men, gay white men, or straight white women), or people who hold two minority identities (like women of color, and lesbians) have different experiences than those holding only majority identities (Cole, 2009).

At the University of Michigan, we have used the concepts I have outlined here, and put them into a model that we discuss with faculty who serve on search committees. The model starts, as I did, with schemas and the lack of critical mass of certain groups (see Figure 1). It reflects the fact that the existence of those two things increases the likelihood of evaluation bias, which leads to persistent underestimation of performance for some people. The accumulation of disadvantage in turn drives some people out of the field, and leads to a lowered success rate among the people who stay, which simply confirms people's original schemas, and prevents critical mass from ever developing. Obviously this system has inertia; it will just keep going if we do nothing to stop it. So when we meet with faculty, we emphasize that the situation is not caused by individual bad actors, so personal guilt is inappropriate. On the other hand, the only solution is for all of us to take responsibility to interrupt this self-reinforcing cycle. And we can take actions that are effective in producing fair outcomes.

SO WHAT IS TO BE DONE?

What can we do? These are four things I want to emphasize; they can be turned into a palindrome—APPA. We can become more AWARE of how it works, we can change our POLICIES and PRACTICES and we can build ACCOUNTABILITY. So I'm just going to quickly talk about these.

AWARENESS

There is an online Implicit Association Test (Nosek, Banaji & Greenwald, 2002), which I encourage you to take: (<https://implicit.harvard.edu/implicit/>). It allows you to check your implicit biases about all kinds of things—not just women in science. That's one way to increase our own personal awareness.



Figure 1.

At Michigan, we also rely on a faculty committee on Strategies and Tactics for Recruiting to Increase Diversity and Excellence, or STRIDE. One of STRIDE's most powerful messages is that diversity and excellence are part of each other; they are compatible, mutual-reinforcing goals, and not opposites. We encourage recruiting the most excellent faculty we can, which means that it must be a faculty that takes advantage of the two-thirds of the population that are not white men. The STRIDE committee engages in peer education campus-wide. We were hiring women scientists at a rate of about 13% before STRIDE existed; now our average post-STRIDE rate is over 30%. We have been able to maintain a rate of around 30% since 2004; we would love to go higher, but we are very pleased that we have maintained an increased rate for quite a long time now.

What did STRIDE do? They developed a peer pedagogy to bring the word to their colleagues. The committee was initially composed of senior faculty in science and engineering (we now have broadened it to include social scientists other than me), but it began as eight senior faculty in science disciplines. They were all very distinguished, and highly respected scholars. They were not traditional advocates for women's issues. The group started out with five men and three women (now the committee is ten, but we try to maintain more men than women on the committee at all times). The committee began by reviewing the social science literature; its first act was self-study and self-education. Now, based on that literature, the committee members make two-and-a-half hour presentations campus-wide, to members of search committees from across campus in the fall. In the liberal arts and engineering colleges, faculty who serve on search committees are required to attend. The presentations rely on empirical evidence; STRIDE committee members talk about studies, and they present the model, which they feel accounts for the persistence of the outcome without an attribution to any notion that somehow women simply are not suited to academic careers. The model does not depend on people who are consciously discriminating. So the second half of the workshop focuses on solutions—what we can do to produce a fairer process and fairer outcomes.

POLICIES AND PRACTICES

In that part of the workshop STRIDE members talk about recruiting and deliberating as two separate parts of the search process that require attention. They point out that the first goal must be to broaden the pool of candidates. They also talk about how deliberations are conducted. Based on the data that has been produced, it is worthwhile to try to decrease ambiguity in the criteria, to increase knowledge of the candidates, to rely on evidence, and to avoid depending on global judgments. One very familiar practice we try to avoid is having a meeting at which everyone is supposed to come in with his or her top three candidates. That all-too-common practice is the enemy of diverse outcomes.

We talk about recruiting proactively year-round. We can't just have "an envelope-opening committee;" we need search committees, committees that are looking even when they do not have a position. We must always be looking for the best talent and the most diverse talent. At Michigan and at many other highly ranked institutions, there is a tendency to recruit from a very narrow range of institutions. There are about five institutions every discipline draws most of its faculty from. Those same institutions are the least diverse in the country. It is no surprise that the applicant pool is in fact less diverse than the pool of doctorates. To overcome this, we have to be aggressive in recruiting from a wider range of institutions. We have to recruit specifically for the low base rate groups, and in addition, for positions that are defined very broadly.

Why broaden the range of institutions? Because talented people may be in all kinds of places! Early career decisions are sometimes made by people on the basis of decisions other than the ranking of the institution. There are people who go somewhere for family reasons, or because they are afraid they would not be hired by the highest-ranking institutions. Indeed there may have been past discrimination by those institutions, and people may internalize their own judgment about the probability that they will

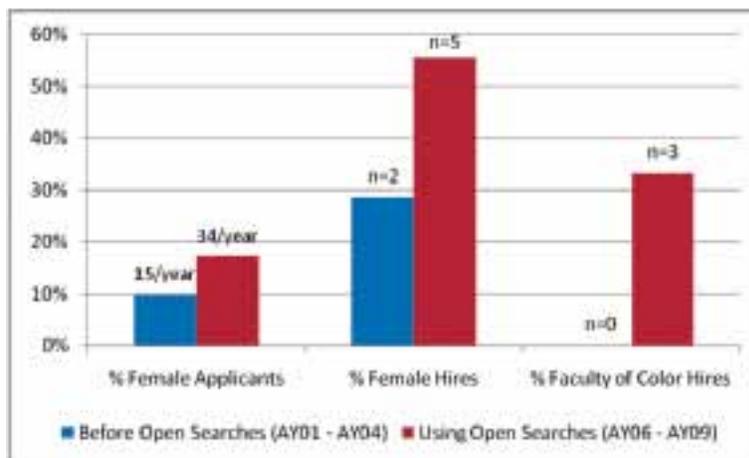


Figure 2. The difference achieved by one UM department

be successful candidates and not apply to certain kinds of institutions. So we have to pursue those people. They think we will not be interested in them, so we have to go after them. We call that, "active recruiting."

Second, we need to avoid discouraging people from applying for positions because of the nature of the position itself. If a job description is too narrow, the likelihood is that very few women and minorities will view themselves as plausible applicants. Then the pool of applicants will not be diverse, and there will be no opportunity to consider diverse candidates. We recommend that you define your position as broadly as possible, and ideally that you operate with a single search committee across multiple positions, so you can consider people who otherwise might fall through the cracks between job definitions.

What happens if you do this? We have over-time data from one science department at Michigan that adopted both active recruiting processes and open searches very early, and has kept track of the impact of that. The first bar (see Figure 2) is the rate of women applicants in the pool that at the beginning was 10%. It is now about 18%, and that's a big difference. But in addition, that 18% is now based on a larger number of applicants overall. Now there are enough human beings—it's 34 women rather than 15 in a given year—that they can actually differentiate among them. They are no longer just “the women” in the pool. These practices have made a major difference in the number of women and underrepresented minorities that department has hired, even though, of course, the absolute numbers are small.

So members of this department, many of whom were skeptical at the beginning, have become true believers. We asked faculty in that department about how they felt about open searching and here are some of the responses that are quite typical. One said, “The open searches led to both a larger number of applicants AND a more diverse applicant pool.” A second said, “I wasn't sure it was the best way to get the best candidates, I am now convinced. Its added new blood.” And the third is a very important point: “The open searches led to a department-wide discussion of all of the applicants. This has the added benefit of everyone on the faculty knowing the candidate and being invested in their success from their first day on campus.”

The processes of open searching and active recruiting had benefits that went well beyond increased diversity—though it did accomplish that too.

Once you have a pool of candidates, and a diverse shortlist, the process of deliberation about candidates is very important. There is evidence that the composition of the search committee matters, as do the clarity of the criteria, and the consistent use of the evidence in avoiding global judgment. Including people who are committed to diversity—regardless of their own race or gender—makes a big difference. Social psychologist Sam Sommers did a terrific study of jury deliberations, that is relevant here (Sommers, 2006). He set up mock juries composed of actual citizens sitting in the Washtenaw County Court waiting to be called up to serve on a real jury. He presented all-white and diverse panels of jury members with material about a case involving an African-American defendant. He found that diverse juries took longer to discuss the case, mentioned more facts, made fewer inaccurate statements in the course of their deliberations, and when an inaccurate statement was made, corrected them. They also discussed more race related issues. What is very important about this study is that this was true for the four white jurors as well as the two African-American jurors on the diverse jury. That is, everybody paid more attention to race, everybody mentioned more facts that relied on the evidence, and so forth. That is what happened when the group

was diverse rather than all white, even without any additional instruction. If search committees are similar, perhaps this is why having women on search committees in STEM disciplines matters (see the report by the Committee on Gender Differences in the Careers of Science, Engineering, and Mathematics Faculty; Committee on Women in Science, Engineering, and Medicine; National Research Council, 2009). I believe jury deliberations and search committees are analogous and one implication of Sommers' findings is that it does take longer to produce better deliberations—but obviously it is worth the extra time.

Finally, we recommend that you make specific judgments in particular areas. If you ask a committee to identify the top three people in general, they will tend to converge on the same people, and it will be a very short list. If you ask people to identify the top three people on each of several different criteria you get a much more diverse pool, and that group of people that you discuss yields a different top three people. Once you have considered what you think about all these different criteria in detail, your top three changes. So that is an important thing about the process. We recommend that when somebody gets up and says, “I didn't go to the job talk and I haven't read the work but I don't really think he's any good,” you should ignore them. Insist that decisions be based on the evidence. We have departments at Michigan that now require at the beginning of any statement about a candidate, whether it's a search committee or a tenure evaluation, that you have to state what you have read, what evidence you been exposed to. What did you read? Did you attend the job talk? Did you talk with the candidate? And people discount the comments of people who are basing their views on little evidence. More formally, we offer a “candidate evaluation tool” to people on our website (<http://sitemaker.umich.edu/advance>). They can tailor it to their own needs, use it to weed out uninformed comments and to focus on the comments of the most informed in particular areas.

ACCOUNTABILITY

We find that it is important to create formal policies, such as the mandated attendance (which we monitor) at the faculty recruitment workshops and then to hold people accountable for the implementation of the policies. Two of our deans now require it and stay in close touch with the ADVANCE program to make sure they know who has not attended; if someone will not go, she or he cannot be on the search committee. The colleges review and approve every search advertisement, so they can bring up the issue of open searches and encourage searches that are not narrowly targeted. They review and approve the composition of search committees, so all male or all white search committees are very rare at the University of Michigan. And each year deans ask chairs to describe the recruitment practices in their department.

The same logic applies to other evaluation settings: annual reviews, tenure reviews, grant reviews, third year reviews, and awards. In all of these processes, the people we consult also have problematic schemas. In their letters and in their phone calls we have to listen for their schemas. (Trix & Psenka, 2003). For example, when they say, “I don’t think she’s quite ready for this,” what does that mean? If you press, you may find that it really just means: “She’s a woman, I didn’t think a woman would be a good candidate for that job.” When we call people we must keep those issues in mind and think about the impact of these evaluation biases in student evaluations.

If we do not build in accountability of all these processes, of course only a few people will do them. So we have to build in accountability to have a wider range of departments, department chairs and faculty, really engage in the practices. We have to monitor the processes and the outcomes, and link rewards to outcomes. The rewards in academia tend to be rather small but they mean a lot to people. So linking awards to outcomes does matter and the evaluation of leaders to how they are doing on these indicators. That is one reason I always talk in public about the departments that are doing such great things, and the deans that are so fully committed to holding their faculty and chairs accountable for good policies and practices. To address unconscious bias we need it all: awareness, changes in policies and practices, and leaders willing to hold people accountable.

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JOYCE WINTERTON

Assistant Administrator For Education, NASA

Building the Next Generation of Astronomers

Joyce Winterton, Assistant Administrator for Education, NASA

It is my honor and pleasure to be part of this conference. In my career, I have often been the first woman to hold a certain position. From an experience like that, you learn that when you have the power to, you want to help and support others. When I think of some of the strongest supporters I've ever had, with respect to advancing women in career positions, they are the fathers of daughters. That includes my father who had three daughters. Now, I have six grandchildren of which five are girls. So when my third-grader granddaughter came home and said "I'm not good in mathematics," I immediately said, "Oh, yes you are." (Don't underestimate us grandmothers—we can be very tenacious!). So I compliment you for your choice of being in such a great discipline and the supporters who got you here. Also, I wanted to mention that I was pleased to see that the conference was dedicated to Beth Brown. I can't think of Beth without thinking about her smile, and I think the reason she smiled is because she loved what she did. So if we want more smiles in our world, clearly we need more people in astronomy.

With the International Year of Astronomy, we have an extra reason to celebrate our accomplishments in astronomy. It's also a time for us to think about what we can do in the future. And that's why you, as women astronomers and astrophysicists, are really so important. We do know that currently, 25% of astronomers worldwide are women, with a lesser percentage in senior leadership positions. That clearly, as we know, is not driven by ability. Why is this? As we've heard today, sometimes choosing a career is based on unconscious perceptions and feelings. Sometimes we tend to want to hire people who look and think like us. Usually, that's not intentional, but it can happen and you won't even know about it unless somebody calls it to your attention. I love this saying: "If you have ten people on a committee and they all think alike and look alike, then you don't need nine of them."

While growing up in a rural part of a western state, I felt my career options were limited. No one really encouraged me to take physics—in fact I'm pretty sure we didn't have physics in my high school. We had some of the hard sciences, but not physics. Now, every high school offers physics to both male and female students. We've made progress, but I'm still surprised, that for all of our investments and for opportunities offered by places like NASA, that our smart female workforce still has such a long way to go to reach parity. I am optimistic, though. We can figure out how to get women into stronger majors. We can look at the workforce where the roles and contributions of women are not as robust, and we can get women into the jobs that NASA needs to

fill. We can continue to build on the successes of the university research community that supports our Science Mission Directorate. Yes, we still have a ways to go. We must work harder to present career choices to young women, and we must find ways to offer them equal opportunity to accomplish the things that we know they have the ability to do.

The White House Council on Women and Girls asked Federal agencies to provide current status report on how each agency addressed issues related to women and girls. In terms of hiring women, you can see (Figure 1) that NASA, for example, has made huge progress since 1964. In the Apollo era, only 1% of NASA's women were at a GS-12 or higher, and now we've made it up to 31%. Progress! But this still doesn't totally reflect the numbers in the workforce. If we look at 1970, the total female workforce at NASA was 17%, and today it is 35%. Sounds great, but what if we look at specifically science and technology careers? You can see that the percentage of females is relatively low. It was 3% in 1970 and today it's 22%. Progress? Yes, undoubtedly, but we still have room to grow. You are a very important part of that growth. You can see that at the Senior Executive Services level that women are still only at 25%. The Council is also trying to determine where we are and the progress that we've made. We want to identify what we need to do and what crosscutting issues need to be resolved, such as providing daycare and equitable salary.

Let's look at the percentage of women in NASA's higher education programs. The percentage of women majoring in each field is on the left hand side and reflects a national average. While NASA doesn't collect data specific to each STEM field, we can see that in 2008, 41% of participants in our higher education programs were female. This is hopeful news, and reflects NASA's commitment to engaging all audiences.

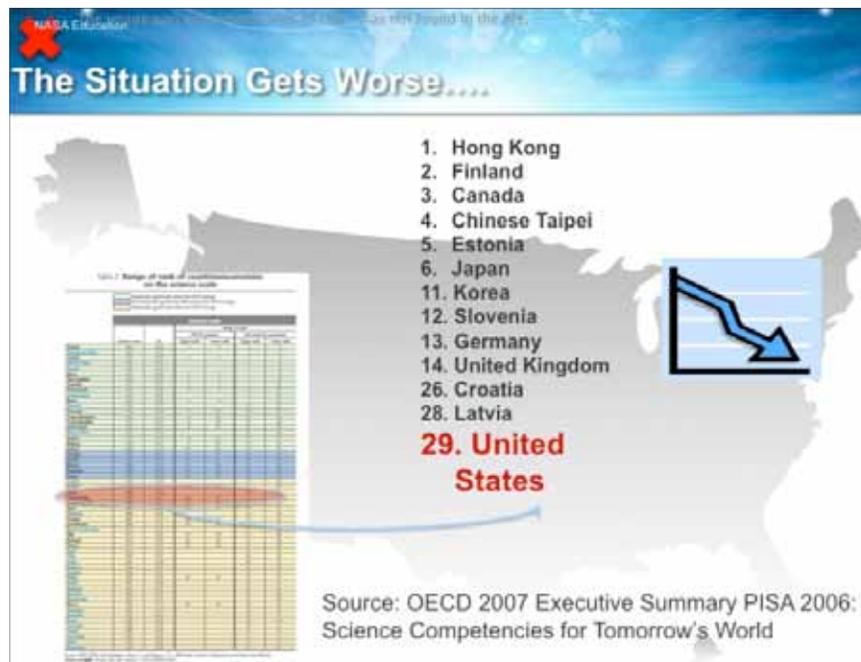
Women Employed at NASA	
1964	Today
<1% women GS12 or higher	31%
1970's	Today
17% Total workforce	35%
3% S&T NASA workforce	22%
<1% Senior Exec Service	25%
NASA's Higher Education Programs	
2004 Nat. Avg.	2008
20.5% Engineering	41%
42% Physical Sciences	
29.1% Math and Computer Science	

Figure 1.

Part of your role at this conference is to analyze what's working, and to help us identify what we can do differently. Sally Ride and other experts have found that it's in about fifth or sixth grade that a lot of young girls develop an attitude that, "it's not really great to be smart, because other kids may not like me; they may think I'm a nerd or a geek." So they decide not to take more coursework in science and mathematics, and they don't think, at that time of STEM careers. We also know that they are then less likely to enroll in undergraduate and graduate programs. But the worst thing is that these are the attitudes of those young girls. They don't take fundamental cases in science and math, and thus rule out any possibility of a future exciting STEM career. As women who have outgrown these options we can change this.

How do we challenge stereotypes and gender biases about achievement in education and appropriate careers for men and women? I just returned from Korea and their educational philosophy appears to be a blanket approach along the lines of, "you will learn it. Everyone can learn it." It's typical for a high school student in Korea to start school at eight o'clock in the morning and go home at ten at night. These students are in classes until about four or five o'clock in the evening. They then have to study for a test that decides at what university they're going to be placed. In Korea, there is strong competition for jobs. Whereas in the US, we tend to say, "Laurie, it's OK if you're not good at math. You're just not a math person." We are pointed in the wrong direction. We need to say, "Laurie, everyone can be good in math. It's essential. So let's get you the help you need: a tutor or teacher that can help you grasp mathematics principles you need. Success for all of our students should be our goal.

I can't think of anything more exciting than helping others understand and supporting the world's appreciation for the mysteries of deep space. Good for you, those of you who have worked with Hubble and other deep space missions, or those of you who look at the sky and want to figure out what happened, and what will happen, and what could happen. To me that is very much a helping profession and we certainly need to make you more visible as female role models for young people.



The chart above shows the results of recent PISA and TIMSS testing. PISA and TIMS are international tests that students take and the performance of a nation's students is then compared to the performance of students in other countries. The TIMSS tests focuses on content knowledge and ability, for instance in math, science, or reading. The PISA focuses on problem solving. You can see that US students are falling behind other nations in both knowledge and ability, but how do we apply that knowledge in a real world situation? When I presented this chart and explained it to about three hundred of our NASA senior leaders, there was an audible gasp. Students performing at a level indicated by these tests are not going to be able to work for NASA or for aerospace contractors. They won't have the basic knowledge, skills, or competencies. President Obama has seen this data and this is why he has been very aggressive about making STEM education a priority for this administration. It's clear that we really need to invest in K-12, undergraduate, graduate, and postdoctoral education. We also need to work with museums and science centers because that's another way to reach young people, their families, and people who want to learn more about science and technology.

I recently met with a national group of educators involved in engineering education. They said that they wanted parents to understand how critical it is for children to keep their career options open by taking a four-year rigorous curriculum of math and science, and in fact, advanced classes when available. By not taking these courses, students begin to self-limit their career opportunities.

Yes, I am one of those who remembers Sputnik! What a motivator. As US students, we were excited; we were going help the US compete in the "race for space" and national

security. The image of that first footprint on the moon was a rallying cry; we wanted to study STEM fields. Now, this year, in your discipline, what is the motivator? How do you get the young people to understand their career options? How can you make them want to gain the skills, foster the innovation, and succeed at problem solving? Yes, then we had the footprint on the moon, but I think today we have other amazing images to help us in our work. Think of some examples like the new images that come back daily from Hubble. When I talk to students about where they got their motivation, I often get the same answer. They looked at the sky. They were amazed, awed, curious, inspired by the solar system and our stars. Using astronomy, we have a great opportunity to capture the interests of young people and ask them, “What will you contribute to our understanding of what you see?”

In the Education Office at NASA, our first goal is to build a strong STEM workforce for NASA and the Nation. To do so, we support higher education by providing experiences to undergraduate and graduate students; we help universities conduct research of interest to NASA; and we assist universities in increasing their ability to compete for federal research dollars. Our second goal is to attract and retain elementary, middle and high school students in STEM fields. We help teachers keep classes interesting. We partner with outside organizations to encourage students to have fun STEM experiences outside of school, such as activities at museums, science centers, planetariums, or through community-based organizations like the Girl Scouts and Boy Scouts. By using NASA’s materials, images, and people, these groups can enhance both student interest and their knowledge in STEM.



One of NASA's strengths, (and one in which I hope you will contribute to), is helping students see the connection between their academic study and real world experience. It actively demonstrates why you need that academic skill or knowledge. It is exciting when students have access to and analyze real-time data. For instance, the Globe Project allows students to collect climate data, analyze results, and work with students from other nations. Students don't want to be lectured; they want to participate in hands-on activities. They want to have the real experience and a launch project can act as a motivator for understanding how the parts of STEM all come together in a rocket-bound experiment. A simulation can be a great learning opportunity, but how much more exciting to actually be a team member for a mission? Through the New Horizon's mission offered by NASA's Science Mission Directorate, we have a student-developed dust counter that's collecting dust and data as it moves through our solar system to different planets.

What young people need to see is women doing the work. We know young people don't understand what engineers do. Many girls and boys don't even know that there are future jobs related to astronomy. The fact is that a significantly high proportion of current engineers had a father, relative, or some close role model who was an engineer. If the older generation of engineers were mostly male, this trend would tend to perpetuate a lack of women and diversity in that field. We all are, or know, women engineers and scientists. So let's get out there and be role models.

To really have an impact on others, one has to be able to tell a story. When it comes to astronomy, I can do it at a very superficial level, but it's really you who are the experts, using your own words, that can tell a solid story that young people understand. I am surprised at the number of people that still haven't quite grasped that these (Hubble deep space) images are new, and only the smallest hint of things to come. You can put these pictures into a context about the data we will be collecting and describe your role in interpreting what is happening. And you can do it in a way that lay people can understand—and we can help you. It may be an interview and a graphic in USA TODAY, or a dialogue in a journal for school counselors that helps students identify exciting career opportunities.

We do need to do a better job of highlighting to students their career options and finding new ways of doing this. We want to help students become informed about NASA and the wide breadth of disciplines that are of interest to our partners and us. We've learned that in a group of 500 counselors, there may be only five or six that have any kind of background in the hard sciences. Instead of just assuming that career counselors understand the kind of work we do and what preparation is required, we need to

be more proactive and instruct them. Career counselors need to be able to point the students to career profiles, interviews, and personal stories of people in that field. They need access to you.



These high school students are participating in a sounding rocket launch and are collecting scientific data that they will later analyze. When I mentioned to the students in Korea the idea of being able to do a launch and collect the data was amazing but it didn't intimidate them. Again, how can we better prepare our students to be innovators who can keep up with and continue to challenge our international partners?



This photo was taken at the Star Night at the White House event. The students were having fun while learning—as were President and Mrs. Obama. These hands-on special events are a great way to motivate students; and it doesn't hurt that it is also a great way to get political leaders to understand the value of what we do.

We need to identify significant events, like the Hubble servicing mission, and use them as real-life stories of engineering and technology challenges that were tackled with innovation, ingenuity, and real world problem solving. These technology challenges provide a good example of how the engineering and science work together to achieve results we never thought of—like the new Hubble images. I think that NASA does a great job at showing the integral partnerships of science and mathematics and engineering. You must have a diversity of experience and knowledge, coming together as a team if you are to do things that have never been done before. NASA and industry need our workers to have this perspective and these foundational skills. But students need to know that such things exist, and then be encouraged to do it—especially women and girls. I urge you to really touch the world through what you do.



This photo shows President Obama talking to the STS-119 astronauts while their Shuttle was in-orbit around the Earth. Also in the picture are Senator Bill Nelson from Florida; Dr. John Holdren, Director of the Office of Science Technology Policy; and Senator Kay Bailey Hutchison from Texas.

That event was a chance to show our policymakers about how space inspires people. It was also a great opportunity to show students that the payoff in doing what you love is worth that hard work. When you're in the lab when everybody else is out having a good time, you are investing in your future and it's going to be worth it. But events showing how space inspires people don't happen as often as we'd like. So we really need you to talk about your experience and share your expertise.

Our NASA Administrator and our Deputy Administrator care deeply about students and education. They are, and will continue to be strong supporters of the work you do and how you can share your experiences to inspire our future workforce. The diversity in people interested in NASA's work is encouraging. When students see teachers and scientists that look like them, it reinforces the idea that everyone can achieve success.

Lately, there have been a lot of new education initiatives and working groups for which we are providing support. One of the groups we work with is the National Science and Technology Council Subcommittee on Education, there are also subcommittees on innovation and competitiveness to which we provide input. This administration is really looking at how we utilize our resources across the federal government. An important part of this is placing a strong focus on setting performance targets and metrics of success. We are also looking for more synergy between partners, including other agencies, academia, foundations, and private groups. The Gates Foundation has established STEM academies that leverage the expertise and resources of partners in Ohio, Texas, California, and Florida. There are a number of others who do, and can do the same thing. But let's work cooperatively to reduce duplication, spread resources more widely, benefit from education and subject matter experts, like you. Other initiatives include the active and deliberate engagement of underserved and underrepresented audiences. Our minority-targeting programs are important, but we need to increase the inclusion of all audiences in our non-targeted NASA education programs. We want to see diversity as a given across all of our activities, not only achieved by targeted projects.

Let's get back to you and this audience. What can you do to get more women and girls into these fields? What can you do to help improve working conditions and improve retention of women? Success here is a two-way street, something in which we can find a win-win. You might consider adopting a classroom or a teacher. In many schools, science coursework has been all but eliminated. I recently talked to a science teacher who said she is penalized if she spends too much time on science topics, as the school only tested language arts and mathematics. As a community, we need to provide out-of-school science education activities. We need to provide resources for educators, and help to science teachers when they need more in-depth training or access to experts. We need to support students who want to become teachers. Last year, Idaho and Arkansas graduated only two physics teachers. Two new teachers do not come close to meeting the needs of those states. Perhaps there are innovative ways that we can find of meeting these needs by supporting new on-line teaching efforts. President Obama recognizes that federal agencies have supported STEM, but he's challenged NASA and others to do even more to support our schools. We have fabulous content, images, education materials, and experts that we can share. We need to offer our support not only to the

schools our children and grandchildren attend, but also those schools that are financially challenged, or that are located in distant rural and urban communities.

Clearly you can support engagement of women and girls by being a role model. Don't ever underestimate your power, especially if you are a young person and can be a "near-peer" mentor. Young people tend to identify with and place confidence in peers. If you are a young professional, you may find that students will more readily listen to you. Frankly, they'll think that you are in a position to understand their world and see it as they do. You can also coach science and engineering teams, like those in the FIRST Robotics competitions.

Don't like competition? You can be a mentor through Girl Scout meetings, contribute to blogs or dialogue with young people on social networks. You can volunteer at open house events at your university or a NASA center. Your presence and willingness to talk about science will help students and their parents understand future career opportunities. You can lead or speak at an astronomy club. You can put a warm and approachable face on a career that may seem intimidating (that's you, astrophysicists!) If your community doesn't have one, why not start a new activity, a club, or start one on-line, or in a virtual world? Do whatever you think would interest young people and the public. All you have to do is just be you, and share your personal experience. Tell personal stories and describe your successes, your challenges, and maybe even some of the times you were less than 100% successful. I think people want to hear you being honest and saying: "Yup, you know I interviewed for two jobs and I didn't get them. It was hard, and I was very discouraged. But you know what? I got that third one that was just right for me."

Yes, some of this will take energy, and may take some time. But a lot of engagements don't have to take time away from your tasks. You might even feel that the connection to young people energizes your work. I just participated in my first Second Life experience, and I now have an avatar, even if someone else has to help me to operate it. It just goes to show that even old dogs can learn new tricks—so those of you who aren't exactly "young professionals" aren't off the hook. You need to get out there. Be a mentor to students, but how about becoming a mentor and coach to other early career professionals? How important it can be when a female colleague thinks she's reached the end, and you are there to say, "You know, I experienced the same thing. Twenty years later, I'm glad I stayed. Let me help you figure this out." Both of you will benefit from this relationship. With technologies that are out there today, you can reach people across

the globe. As the only woman in your department, don't feel that you can't mentor because no one is nearby. Get on social networks and find another woman who is also alone in her department. Geographic distance is no longer a barrier.

In closing, I think, Beth Brown would encourage you to engage other women. I can imagine her smiling and saying, "Keep doing the work you love, but take it further. Do what I did—support education, engage more young people, more females, more school leaders, and more decision-makers. Understand the critical need for diverse workforce and do your part to make that happen."

Thank you very much.



How the Professional Community Can Impact Percentages and Retention

P A N E L I S T S

L. To R.: Meg Urry, Yale University; Lee Anne Willson, Iowa State;
Matt Mountain, Space Telescope Science Institute;
Debra Elmegreen, Vassar College; Jim Ulvestad, NRAO

Panel Discussion: How the Professional Community can Impact Percentages and Retention

Chair: **Meg Urry** Panelists: **Jim Ulvestad, Debra Elmegreen, Matt Mountain, Lee Anne Willson**

Panelists' names are abbreviated by initials. Each made a brief statement and then the session was opened for questions from the audience.

Jim Ulvestad is Assistant Director of the National Radio Astronomy Observatory, formerly director of the Very Large Array and Very Long Baseline Array, and currently Head of its New Initiatives Office. As a past member of the Committee on the Status of Women in Astronomy (CSWA) and Chair of the Astro2010 Study Group on Demographics, he has worked for years on the issues we are discussing today.

JU: I learned a lot from chairing the Astro2010 Demographics Study for the Decadal Survey, and I will share some of that with you today. I have two main points to make and then I would like to talk about the special challenges of employment at a remote ground-based observatory like the VLA and some of our other observatories.

My first point concerns the outcome of the second Women in Astronomy meeting, which was encoded in the Pasadena recommendations (www.aas.org/cswa/pasadenarecs.html). These were aimed primarily at increasing the number of tenured/tenure-track women in astronomy, but many of the recommendations are also applicable to minorities and non-tenure granting institutions. A key recommendation is that search committees should have diverse membership—at least two women and/or people who are aware of the unconscious biases against women and minorities—and it should consider a diverse candidate pool. Hiring is a key “filtering” point in a scientific career, and to be as strong a field as possible, we have to get it right. We all need to put the Pasadena recommendations into practice at our institutions.

My second point is that we need to think carefully about how to educate our astronomy students for careers that may not be faculty positions. Roughly half of all active astronomers are in faculty positions while 50% are in non-tenure-track positions. We should not think of success in terms of tenure-track academic jobs only. Over the past two decades, the number of newly minted astronomers has increased from ~100 PhDs per year to ~200 per year, but the number of tenured positions has not doubled over that time (it has grown by about 50%). In any case, the typical faculty member educates more than one PhD in her/his ~35-year career, so it is clear that not all astronomy PhDs can expect to have a tenure-track position. Astronomy is great for

training people in STEM (Science, Technology, Engineering and Mathematics), but mentors and students need to plan appropriately for different possible career tracks¹.

Let me end with a few words about a built-in career issue for astronomers. As a radio astronomer, I have worked at remote observatories far from big cities. This is very different from the large metropolitan research centers that are typical locations for the NASA Great Observatory science centers, and the challenges for dual-career couples are huge. Moving to a remote area may leave you without services others rely on, like child-care providers or facilities for aging parents. You don't have the luxury of picking among many options, as you would in a city. Remote observatories may offer limited or no local health care options. Going to Chile for dark, dry skies may leave a partner jobless if they are not allowed to work in that country. This makes it a real challenge to staff the large ground-based observatories in a diverse way. Observatories need to be aware of these challenges and willing to work with prospective hires and/or to change the way the observatories have historically been run. For example, one option is to operate science centers for observatories like the larger research centers, i.e., locate them in big cities, where family and other employment issues can be more easily accommodated.

Debbie Elmegreen is the Maria Mitchell Professor of Astronomy at Vassar College and Chair of the Department of Physics and Astronomy. She is also President-elect of the AAS and a member of the Astro2010 Survey Committee. She was a long-time Chair of the CSWA, and started the electronic newsletter.

DE: First I would like to bring everyone's attention to the CSWA website (<http://www.aas.org/cswa/>) and the AASWOMEN newsletter, if you don't already know about them.

Next, I want to stress that we can help our junior colleagues by nominating them for prizes to recognize their research. I have seen that the AAS nominating committee doesn't get nearly enough nominations for the AAS prizes, so I wanted to point out that

¹In a recent personal communication (3/1/2010) Dr. Ulvestad was asked how many faculty positions are available per year. Ulvestad wrote; "Our best estimate is that there are about 1700 astro faculty positions in the US, so if they all turn over once in 35 years, there would be nearly 50 per year. But best evidence is that at least in the last couple of years, there have only been about 20-25 astro faculty hires per year. This could be delayed retirements because of the stock market going down, or else open positions that are not filled because universities are trying to make their budgets balance." Rachel Ivie added; "In 2006 and again in 2008, astronomy departments "recruited" for 24-25 faculty positions. In 2008, physics departments recruited for 163 astronomers (no data for 2006). We only began collecting data about astronomy recruitments recently. However, we have a long history of collecting data from physics departments about number of recruitments and number of hires. In physics, the number of recruitments is typically 40% higher than the number of hires. I don't have data on the actual number of astronomy faculty hired. We are currently working with the AAS Committee on Employment to develop a survey that will collect these data." (3/4/2010)

you do not have to be at someone's institution to nominate them. So I hope you will consider nominating a junior colleague for the Warner and Pierce prizes for astronomers younger than 36.

I am proud to say that three of the seven physicists and astronomers at Vassar are women, which may not be so surprising because Vassar did start as a women's college. When the Pasadena Recommendations first came out, I was happy to see that Vassar already followed most of them. But a small college has its pros and cons, with one of the largest problems being the two-body problem; unlike a large university, we generally do not have flexibility in hiring a spouse along with a new hire. Also, there are generally only a small number of astronomers at small institutions. However, we are part of the Keck Northeast Astronomy Consortium of eight small colleges, which has fostered collaborations and an exchange of students. In this way we have broadened the baseline of activities, and our Keck NSF REU program has 45% participation by women.

***Matt Mountain** is the Director of the Space Telescope Science Institute (STScI), where he moved from his position as Director of the Gemini Observatories. Matt appointed STScI's first Committee on the Future of the Workplace.*

MM: I became the director of STScI when the percentage of women astronomers in the institute was at its lowest. Why did all the women who had been there leave such a successful scientific institution? We had to examine much more closely how science and engineering were done at STScI. The first thing we had to recognize is that we have strong traditions in astronomy and astrophysics. The individual skill of an astronomer, particularly the observational astronomer, brought considerable "self worth." The style of science debate was always inherently combative, to the point where words like "excellence," "competitive" and "combative" were synonymous. The pursuit of excellence was somehow associated with a "harsh environment" as the natural by-product, or phrases such as "survival of the fittest" were often used.

At the core of transforming STScI into a 21st Century organization is how diverse is the constituency that feels empowered to participate in that debate? This is much more than simply "bringing in a diverse work force"—many organizations (including our own) try this all the time—but if we do not also change the environment and approach to our work, nothing actually changes. STScI was the originator of the Baltimore Charter, but over time our organization reverted back to its original "non-diverse" state. What we have worked to change at the institute is not the pursuit of excellence—sustaining excellence through a competitive, energetic, vocal and motivated staff is critical to the vitality of STScI—but how that competition of ideas is waged and who feels empowered to participate. This is not a "PC issue"—it is how we need to succeed

in the modern scientific era. A look at the top cited papers in astronomy and astrophysics shows that today typically teams produce these. As has been recognized by several studies, modern science, particularly space science, is becoming a multi-disciplinary, team-enabled endeavor. Hence the skills and participation required to succeed and excel are very different from those required perhaps no more than a decade ago.

Changing the culture at an institution like ours is never easy, but there are some things that can be done quickly. First, bring in a committee like our “Committee on the Future of the Workplace” to advise the director on a regular basis, and then listen to their advice! For example, STScI had many friendly policies, like stopping the tenure clock, but it was never used. Fathers were allowed to, but never took, family leave. Our committee pointed out many people didn’t know about all our policies, and we brought together all of our family friendly policies in a brochure, to make them better known to our employees. We also then asked our senior folks to start setting the example of how these could be used, even if they were small changes. For example, I never attend afternoon or evening meetings on Halloween, or travel on my kid’s birthdays.

Secondly, recognize that we, as science leaders, have a responsibility to change how we do science, we have to change the rules of the game. Fran Bagenal said earlier that some of us are at a disadvantage if we are to simultaneously mentor colleagues, take part in public outreach, etc., all while producing science. However, we can either keep doing the same thing, again and again (and the truest sign of insanity is doing the same thing again and again expecting a different result) or we take on the challenge to change the rules of our field. If we don’t, and astronomy and astrophysics becomes perceived as an elite “priesthood” undertaken solely by a narrowly defined (and recognizable) group of individuals – we will have only ourselves to blame when the rest of the world moves on without us.

Lee Anne Willson is a University Professor of Physics and Astronomy at Iowa State University. She won the Annie Jump Cannon prize of the AAS in 1980, is a past chair of the CSWA, and helped conduct the first survey of women in astronomy. Lee Anne is currently a Vice President of the American Astronomical Society.

LAW: The Iowa State Advance program produced a web page similar to that set up at the University of Michigan, with resources for search committees (<http://www.advance.iastate.edu/>). This page includes background information (what minimizes the effects of unconscious bias/research into unconscious bias), best practices summaries and sample forms. Using this made it far easier for me to get some changes made in our departmental practices.

Hiring committees can minimize bias by ranking separately the different aspects of each candidate—such as publications, citations, teaching abilities, successful proposals, etc.—rather than simply ranking them on a single overall estimate of excellence. Votes within the committee for each category should be by secret ballot so that no one member of the committee unduly influences another. The committee should conduct phone interviews for 10-15 candidates, in order to collect more information on candidates while retaining a streamlined and financially sound process. The top 3-5 candidates should visit the university for face-to-face interviews.

A big university in a small town has to deal with the two-body problem. Iowa just pulled off a joint physics/astronomy hire but in general, we have trouble attracting faculty candidates because of the small town. Even though we have resources to address this issue and we can often solve the problem, people don't give us the chance to show what can be done. I encourage people to broaden their choice of where they apply, geographically and in terms of career path.

Meg Urry is the Israel Munson Professor of Physics and Astronomy at Yale University, Chair of the Physics Department, and Director of the Yale Center for Astronomy and Astrophysics. Before moving to Yale in 2001, she spent 14 years at the Space Telescope Science Institute. She is a former Chair of the CSWA and former editor of its newsletter, STATUS.

MU: Let me start with a little history, for context. When we organized the first meeting on Women in Astronomy in 1992 (“WIA I”), we thought we needed to address why there were so few women in astronomy—but it turned out that we first had to convince our colleagues that a problem even existed. So we started by showing there were very few women in our field. The statistics at STScI were particularly alarming since all hiring occurred in the modern era, after 1981, so historical imbalances were not the cause. Out of WIA1, we produced the Baltimore Charter, which at the time was seen as radical but now reads as mild and pretty obvious.

The goal of the second WIA meeting, in Pasadena, was to find concrete solutions to the clear problem of under-representation of women. After the conference, at the January AAS meeting, Pat Knezek and I wrote down a draft of the Pasadena Recommendations. One key point was that diversity and excellence are aligned. Some people think we have to lower our standards to be diverse, but it is the alternative—of ignoring or undervaluing women and minorities—that means dipping lower in the applicant pool and thus lowering standards. Excellence is best served by a diverse applicant pool.

Now we are at the third WIA meeting. How have things changed? Diversity is now widely understood to be important, although not everyone understands why we haven't yet achieved it. When I was hired at STScI, I was one of two women; Anne Kinney

was the other. Under Riccardo Giacconi's leadership, two more women were hired the following year, and the institute continued to make great strides forward. So Riccardo was instrumental in building a diverse workforce. But even Riccardo doesn't really get it. In his recent book on X-ray astronomy, he made a disparaging mention of the 2003 study that had criticized STScI for its climate for women, saying that the women leaving STScI must not have been able to compete in the climate of excellence there. In my view, he couldn't be more misguided in his interpretation.

So the issue for this WIA III meeting might be, why has the advancement of women and minorities in astronomy and in science been so slow, and what can we do to accelerate it?

QUESTIONS FROM THE AUDIENCE

1) Audience member: *What institutional support or incentives have you set up to encourage mentoring?*

JU: Not enough. The mentoring we do at NRAO is hiring postdoc and mentoring de facto. We are now discussing whether a formal mentoring program should be set up. It is important to know your employees well.

MM: We don't do anything formally at STScI in the sense its part of a person's professional requirement—but we are re-examining this. The Johns Hopkins medical school has a very successful mentoring program in which mentoring is considered a professional responsibility. Mentoring is an essential aspect of a successful science institution.

2) Chanda Prescod-Weinstein (Perimeter Institute): *As a black graduate student, I believe mentoring is needed for survival and is something that we all must do. How do we talk about community-based support? The majority of black physicists in the US have been trained in historically black colleges. How do we advance this community?*

MU: This is an important comment: being a double minority is a real issue, so thank you for bringing this up. An important theme of this meeting is that we have to focus our efforts on under-represented minorities, who have not advanced in our profession as markedly as women have.

3) Sally Dodson-Robinson (University of Texas): *When women were leaving STScI, you said that they all had really great reasons that weren't specific to being women, but that there was a pattern. How do you go from random incidents to getting people to see a problem and trying to fix it? It isn't just one bad year.*

MM: It is difficult to see trends when you are looking at only one point at a time. Many women were not comfortable in the culture at STScI. Probably some men weren't either but the women had places to go. We can think of those women as “canaries in the coal mine”—the culture was bad for many.

4) Audience member: *The economy is bad right now, what is hiring like in this environment? Are people considering the lack of positions for the scientists entering the field?*

DE: Remember, faculty positions are not the only positions. At a colloquium I gave recently, graduate students were asked if they were mentored about other career options and they balked at not becoming a faculty member after all the hard work to get a PhD. Nonetheless, as Jim Ulvestad said earlier, half of us work outside academia.

JU: Several of the white papers submitted to Astro2010 stated that we need to broaden career paths for a “trained astronomer.” As NRAO has hired more women astronomers, they have stayed. They are interested in radio instrumentation and radio science, so they stay—they have found their niche. Within astronomy, can young people have other focuses? Maybe universities and other institutions need to consider offering space policy, science education, or instrumentation options, perhaps as secondary areas of specialization, to give astronomy lovers other relevant career directions.

MU: I know many young astronomers who have developed careers outside of colleges and universities and I don't know any who are unhappy with that decision. Their work is challenging and interesting, and it fully utilizes their skills. It's not the case that faculty jobs are better or somehow more valuable than other jobs.

5) Pat Knezek (NOAO): *I'm thrilled to hear that many institutions mentor graduate students and postdocs, but we also need to mentor mid-career people, in order to encourage them to be the best that they can be. You hired them because you thought they were excellent, so you should work to retain them and to enable them to do their best work. Communication is a really important piece of this. Have others read your proposals before you submit them so that you can check whether your argument gets through and to make sure spelling and grammar don't throw you out of the running.*

6) Katie Alatalo (UC Berkeley): *There was mention earlier of a bottleneck of universities where top scientists try to get tenure-track positions, but those universities may be the least progressive. How can we fix this?*

MU: I'm not sure that top-ranked universities are doing worse in terms of diversity, but I think we do have to change the culture at many places, across the board.

LAW: Don't underestimate the power of one person in leadership to set the culture. Work towards having leadership with the quality to perceive these issues.

DE: Also remember that you needn't be at big universities to do astronomy. You can do your research anywhere, not just at a university. Collaborations are important so you don't feel isolated.

7) Audience Member: *Coming back to the two-body problem, what is the percentage of women in astronomy married to another astronomer?*

Various panelists: Two-thirds of married women in physics are married to a scientist (see report by McNeil and Sher in *Physics Today* about 10-15 years ago). The number for men is 20%. A two-institute study in Europe found that 75% of women scientists in the US, vs. 30% of those in Europe, are involved with another scientist.

8) Adam Burgasser (MIT, UCSD): *Two things. First, we must each have mentors, plural, to get a good range of opinions. Second, Matt Mountain said that the leadership has to change the culture. Not all institutions are enlightened. Junior faculty are very concerned by this but are not the decision makers nor are they on the search committees or colloquium committees.*

MU: Good point. You can speak up but it can be dangerous—you can get run over. Don't argue. Gently let your colleagues know that without diversity they will fall short of excellence.

9) Alyssa Gilbert (University of Western Ontario): *With regard to the two-body problem, is it possible to work remotely? What can the AAS do? Is there a way to reward teaching and outreach and not glorify just the research?*

JU: I am NRAO's first full-time telecommuter. Sometimes a work group needs to be together in the same building, at least some of the time, since astronomy is shifting towards more large-scale projects and surveys. Good communication options can provide flexibility for staff that are trying to juggle dual careers, family care, and other demands on their time. Consider telecommuting 50% of the time, being there 50% time. Some of the Jansky Postdoctoral Fellowships can be taken anywhere now instead of just at NRAO sites, or can be shared (one year at an NRAO site, one or two years elsewhere), which is a step in the right direction.

DE: I like the idea of rewarding teaching and EPO more. I will look into this further with regard to the AAS.

10) Rita Sambruna (NASA/GSFC): *You mention that leaders need to change the rules of the game in order to open opportunities for minorities, but can you give specific examples on how to encourage minorities to get involved in STEM?*

MM: We brought in an outside committee to look at STScI. They have given us a great deal of feedback. To give just a few examples: we don't have meetings at five PM because parents need to get home for kids, but leadership has to make this happen. As for minorities, we are stepping up our internship programs to better target minorities. Keivan Stassun, who chairs the AAS Committee on Minorities, is a member of our outside committee, so he has been helping us.

11) Erin Zekis (University of Colorado at Boulder): *Is there training at universities and institutes about biases, as there is for sexual harassment issues?*

MU: Some institutions do this. For example, the wonderful NSF ADVANCE program has now funded roughly 30 institutions to "transform" themselves, and many now have tutorials or lectures on implicit bias, conducting fair and unbiased job searches and evaluations, and so on. I think this is having a real impact. But the AAS and the CSWA may be able to do more.

12) Anne Kinney (NASA/GSFC and chief organizer of WIAIII): *Our next meeting must focus on minorities in astronomy and not just on women.*

The chair and panelists would like to extend their gratitude to Lori Feaga for taking the notes that made this paper possible.



LILY MCNAIR

Spelman College

HBCU Perspectives and Research Programs: Spelman College as a Model for Success in the STEM Fields

Lily D. McNair, Spelman College

INTRODUCTION

Spelman College is a one-hundred-twenty-nine-year-old black women's college that has created a culture of excellence and success in the sciences. This paper will focus on the history of Science, Technology, Engineering, and Mathematics (STEM) at Spelman College. We will speak of the importance of institutional context and the strategic initiatives that emerged out of a very powerful vision—a vision that should stand as an example not just for black colleges and universities but also for all institutions of higher learning.

How do we change the rules of the game? How do we promote and advance the idea of diversity and excellence and align them as perfectly as possible with the goals of STEM initiatives? And how do we look at the notions of culture, schemas, expectations, unconscious bias, and unearned privilege in the context of a historically black college for women?

HISTORY

Spelman College is this nation's oldest historically black college for women. In 1881 Sophia B. Packard and Harriett E. Giles, both schoolteachers and missionaries from New England, started a school for newly freed female slaves in the basement of Atlanta's Friendship Baptist church. The two founders, with the help of the church pastor Frank Quarles, were concerned with the lack of educational opportunities for the newly freed female slaves. On April 11th the doors opened to eleven black female students. Of these, ten were women, some having been former slaves, and one was an ambitious younger black female wishing to get a basic education. Harriett Giles mentions in her surviving journal that she held her first class with eleven "Scholars." We should take note of the word and try to envision what the expectations and standards of the first class of Spelman students were—students who were expected to perform as "Scholars."

The student population at the church grew to such an extent that it was evident it needed to expand. With the generosity of John D. Rockefeller, whom the two missionaries had met at a conference, the school moved from the basement of the church to a nine-acre location that had once been used by Union troops during the Civil War. The school was renamed in honor of Rockefeller's in-laws as Spelman College.

THE SCIENCES AT SPELMAN

Prior to 1950, Biology and Mathematics were the only two science departments at Spelman. In 1976 the Chemistry Department was established, and is now accredited by the American Chemical Society. Computer and Information Sciences and the Department of Physics are both fairly new departments. The Physics Department now has five full time tenured faculty: four males and one African-American woman, who in 1999 was the fifth black woman to earn her PhD in physics at MIT.

Spelman also has an accredited Environmental Sciences and Studies program offering both the major and minor; a dual degree engineering program; a Public Health minor in collaboration with Morehouse College; and a minor in Environmental Health. The college offers a bachelor's of science degree in all of these STEM fields.

THE PROMINENCE OF STEM MAJORS AT SPELMAN

Today the college's total enrollment is 2150 students, reflecting students from across the United States and several international locations totally focused on undergraduate education. Of the total number of students, STEM fields account for 30% of all majors—an amazing percentage considering that Spelman is a women's college and an Historically Black College and University (HBCU). The majority of these majors are in biology. One-third of Spelman graduates are STEM majors. We now have seventy-five chemistry majors; one hundred mathematics majors; two-hundred-eighty-seven in biology; twenty-five in computer sciences; twenty-seven in physics (approximately seven physics majors graduate every year); twenty-five in environmental science; and about seventy-five in our dual-degree engineering program. Each of these dual-degree engineering students graduates at the end of five years with a degree in a science from Spelman as well as an engineering degree from one of our partnering institutions. The majority of the students who obtain an engineering degree go on to the Georgia Institute of Technology or the University of Michigan.

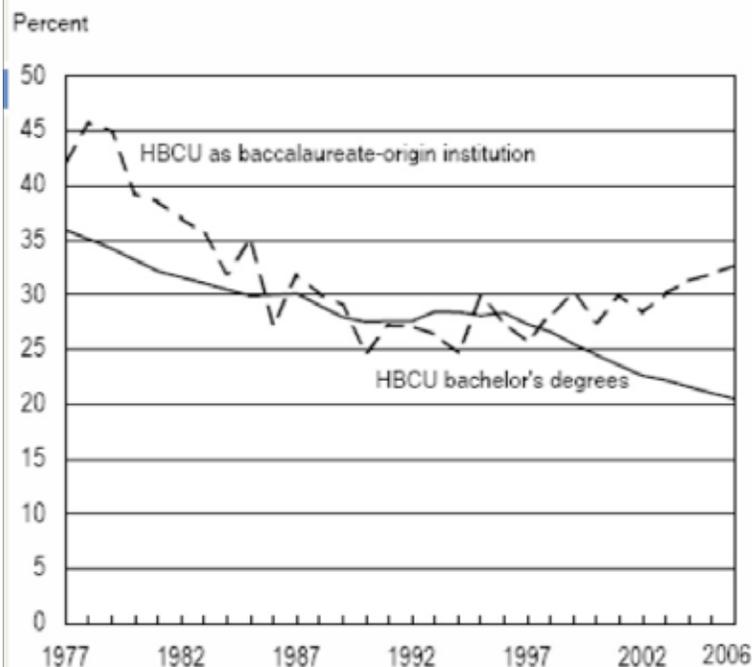
A recent NSF study ranked Spelman as the number two undergraduate institution of origin for black PhDs in STEM. ["Role of HBCUs as Baccalaureate—Origin Institutions of Black and S & E Doctorate Recipients" Joan Burelli and Alan Pappaport <http://nsf.gov/statistics/inbrief/nsf08319/>]. One-hundred-three PhDs in STEM have graduated from the college in the past ten years. The number one institution is Howard University in Washington DC, with an enrollment of 11,000 students compared to Spelman's 2150. Spelman is extremely proud of this achievement, which reflects the outstanding undergraduate STEM education our students obtain.

HISTORICALLY BLACK COLLEGES AND UNIVERSITIES

In 2006 almost 30% of all black PhDs in STEM earned their bachelor's degrees at an Historically Black College and University (HBCU), representing approximately 10.1 black PhDs per one thousand bachelors. But at schools that are non-HBCUs this number falls to about 7.9 black PhDs per one thousand bachelors. So the question arises, what is happening at HBCUs that makes the students so successful in STEM?

If we are to be determined, intentional, and strategic about increasing diversity in astronomy, STEM, and physics, there are certain lessons and models and best practices that we can learn from HBCUs.

FIGURE 1. Black S&E doctorate recipients with HBCU baccalaureate degrees and black bachelor's degrees conferred by HBCU institutions: 1977–2006

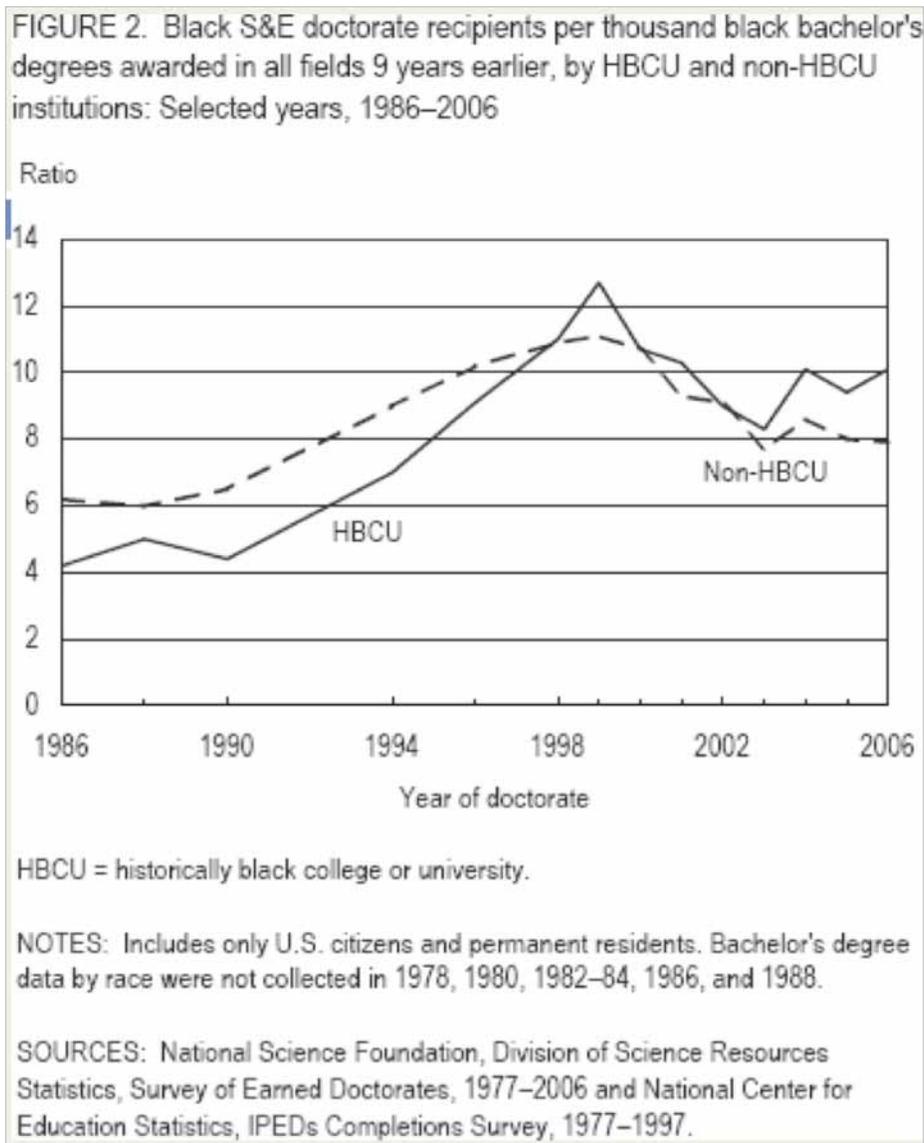


HBCU = historically black college or university.

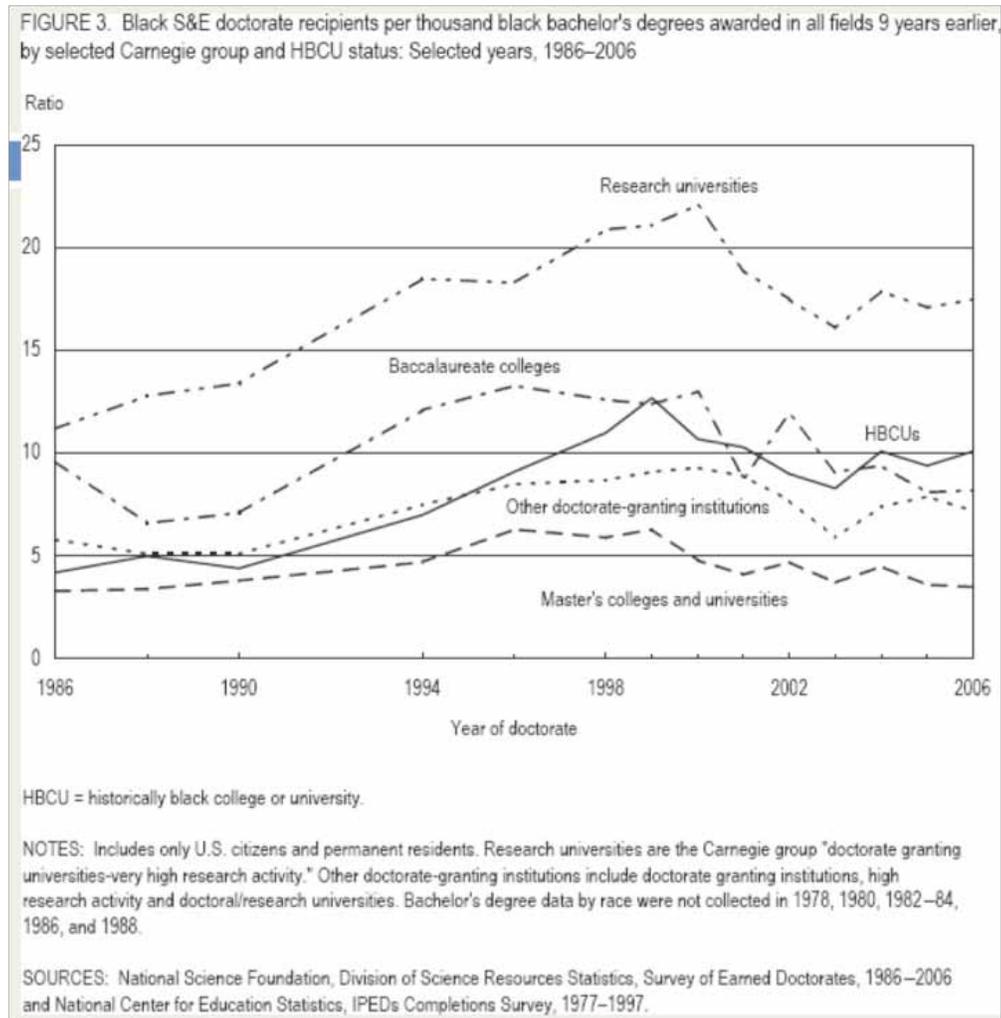
NOTES: Includes only U.S. citizens and permanent residents. Bachelor's degree data by race are not available for 1978, 1980, 1982–84, 1986, 1988, and 1999.

SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, 1977–2006 and National Center for Education Statistics, IPEDs Completions Survey, 1977–2006.

The graph in Figure 1 shows that black science and engineering doctorate recipients that are at HBCUs have a higher rate of earning PhDs than those at non-HBCUs. Figure 2 on the next page, looks at the rates for nine years earlier; again, of those students who graduated from HBCUs there is a significantly higher number who went on to earn their PhDs.



Finally, the graph in Figure 3 on the next page shows the proportion of black PhDs in STEM according to selected Carnegie group and HBCU status. While it is clear that research universities produce the highest numbers of PhDs, HBCUs rank second in terms of educating black doctorates in STEM.



The top ten baccalaureate origin institutions of black PhDs in STEM from 1997 to 2006 are as follows:

1. Howard University
2. Spelman College
3. Hampton University
4. Florida A & M University
5. Morehouse College
6. North Carolina A & T University
7. Southern University A & M College, Baton Rouge
8. Xavier University
9. Harvard University
10. University of Maryland at College Park

All of the schools in the top eight positions are HBCUs. Harvard and the University of Maryland are the only two non-HBCU research universities in the top ten producers of black undergraduates who go on to earn PhDs in STEM. Howard University produced two-hundred-and-twenty-four graduates who earned PhDs in STEM during this period; Spelman one-hundred-fifty-three; Morehouse ninety-nine; Xavier seventy-nine; Harvard seventy-three; and UMCP seventy-two. If we are to compare those numbers with other top-ranked Ivy League research universities we see that Brown graduated fifty black PhDs in STEM; Yale forty-eight; and Princeton forty-seven during this same period. Clearly, something is happening at HBCUs that is leading to success and successful completion of doctorates in the STEM fields that is not happening at other institutions.

THE “HBCU EFFECT”

Barabara Whitten and her colleagues conducted several studies of physics departments throughout the country to determine what factors promote the success of women in physics. To a degree, Whitten addressed the “women’s college effect,” in that women physics majors from women’s colleges fared better (completed the major, continued graduate study in physics) than women students from co-ed institutions. Here I’d like to propose that there is an “HBCU effect” and an “HBCU women’s effect.” From this we can learn some very important lessons about complex pathways to success in physics and other STEM fields.

What is happening at Spelman is also happening at many other HBCUs; however, what is extraordinary is that Spelman, a small liberal arts college for black women, has achieved remarkable success in this area. This success shatters stereotypes not only about women but also about how black women can “do” science. There is something about the way that science education and training are being implemented at Spelman that is particularly relevant to understanding the success of Spelman women in STEM. This “something” is reflected in an institutional vision, strategic planning implementation, and intentional cultivation of resources to build and sustain an outstanding academic environment for excellence in STEM.

DR. ETTA FALCONER AND HER VISION

In 1969 Dr. Etta Falconer was the tenth African-American female in the USA to earn a PhD in mathematics. Falconer became chair of the mathematics department at Spelman and along with her colleague Dr. Shirley McBay, a chemist, who was division chair for natural sciences and mathematics at Spelman, announced a bold and new vision. They decided that they would enhance the role of the sciences at Spelman

College. Both women saw no reason why black women could not be at the leading edge in the sciences and mathematics.

Drs. Falconer and McBay collaborated with Spelman's faculty and administrators to get everyone on board and develop a strategic plan to intentionally grow the sciences; to increase the number of majors; and to embark on a capital campaign to garner resources for the construction of a new science center with state-of-the-art laboratory research and teaching facilities.

In 1971, when this vision was first articulated, only ten percent of Spelman's students were majoring in the sciences. The enrollment in science classes was very small and the only majors offered were in biology and math. Only nine percent of the degrees awarded were in these two science fields.

Drs. Falconer and McBay were instrumental in changing Spelman's science and mathematics curricula as well as its physical resources. In the 1970s, science and math faculty shared small, cramped offices and laboratory space. Drs. Falconer and McBay initiated a strategic plan to improve the physical condition of the STEM departments, as well as enhance the curricular and academic support provided to STEM students. They began pre-freshman summer programs that were supported by external funding from agencies such as the NSF and NASA. They made a planned effort to bring in resources so that talented students could come to Spelman the summer before their junior or senior year of high school for science and math programs. They created two types of summer programs, for newly admitted students, one focusing on biomedical sciences and health, the other on physical sciences and engineering.

The Health Careers Office was established, promoting mentoring, professional development and academic support for students pursuing careers in health sciences, medicine, pharmacy, dentistry, and veterinary school. In addition, the Office of Science, Engineering and Technical Careers was created, whose sole purpose was to provide support and preparation for those students who were interested in careers and graduate study in the sciences.

A supplemental development program was also implemented at this time. This program provided academic support to students in introductory and advanced classes in the sciences. The supplemental instructors (SIs) were student peers who had already taken those classes, and had study and instructional sessions that not only reviewed material covered in class, but provided students opportunities to actively apply course material to new problems. These sessions promoted collaborative peer support for the students in sciences and math.

THE IMPORTANCE OF OBTAINING EXTERNAL RESOURCES

In 1987, through funding from NASA, Spelman established a scholarship program for Women in Science and Engineering (WISE). Since its inception, the WISE program has had approximately three-hundred-twenty participants. Of these, forty have gone on to earn their PhDs and half of them have masters' degrees in the sciences.

NASA also awarded Spelman ten million dollars in funding and identified the college as a Model Institution of Excellence that provided resources for faculty research, support and development in STEM. The grant provided the formation of a scholar-teacher program (similar to a post-doc) that brought in junior faculty for a specific type of academic appointment that lasted two to three years and that required research and teaching responsibilities. Several of these scholar-teachers are now in tenure-track positions and some have already earned tenure. This type of resource cultivation was instrumental in growing STEM at Spelman.

The National Institutes of Health provided grant support to establish a number of important research and development programs in biomedical and behavioral research. For example, the National Center on Minority Health and Health Disparities Research Infrastructure in Minority Institutions Program (RIMI) establishes and improves the scientific infrastructure of predominantly minority serving academic institutions. One of the main objectives of this program is to establish a core group of scientists through faculty development and student participation. At Spelman the RIMI program has been instrumental in developing research infrastructure by establishing the start-up for an Office of Sponsored Programs as well as a Core Lab facility. We also have support from NIH programs such as MARC, Minority Access to Research Careers and MBRS, Minority Biomedical Research Support, which are programs that are specifically designed to increase the number of underrepresented minorities, faculty, students, and investigators in the STEM fields. Spelman also has continuous funding from the Howard Hughes Medical Institute to support biomedical research training and curriculum development.

All of the above-mentioned resources established funds to promote faculty development, supporting faculty to obtain tenure, to provide research opportunities for Spelman students, allowing them to have the possibility to actively participate in research in faculty labs (which is particularly critical for junior faculty in tenure-track positions). With the implementation of these programs and their subsequent successes Spelman is able to demonstrate that science can be done with excellence at a small liberal arts college for black women.

Obtaining external funding has been critical for the growth of the sciences at Spelman. These resources have supported the development and implementation of research training programs, faculty development programs, and individual faculty research projects in STEM. Figure 4 below shows that in 2009 STEM research funding totaled 31.3 million dollars.



Figure 4

Figure 4 shows that the chemistry department brought in thirteen million dollars of funding in 2009, the greatest amount of funding of any department. In addition, all the other STEM departments are also well represented. Over 95% of outside funding at Spelman is obtained by STEM departments, which target funding opportunities that are consistent with the research and curricular needs of our STEM programs and faculty.

EDUCATING EXCELLENT STUDENTS AT SPELMAN

From the onset it is made clear to all incoming students that Spelman expects each one of them to succeed. First year students arrive at Orientation knowing that Spelman is a place with an exceptional record of achievement for black women in STEM. There is never the negative, unspoken undertone that one may not succeed. Instead, the message given to these young women is that they can all succeed because over 30% of Spelman women graduate in STEM.

Spelman sets high standards. The higher the standard, the higher the expectations, and the more the students know what is expected of them, the more they are likely to achieve. In order to achieve excellence, Spelman has created a “culture of excellence” within its walls. This has been accomplished by implementing a number of coordinated programs and services for STEM students, such as research training programs, tutorial and academic support programs; seminar series (many of the seminar speakers are research mentors from other universities or become mentors, and many are alumnae) and mentoring programs. Spelman students can look to women who have graduated before them and aspire to their success. One of these women, for example, is Dr. Chekeshia Liddell who was a WISE Scholar at Spelman and is now an assistant professor of material sciences at Cornell University. She has also received the presidential award for excellence in research from the NSF.

There are also informal social activities at Spelman that contribute to a lively, supportive, student-centered STEM environment. Each of the STEM departments at Spelman has a student club. During my first year at Spelman I was asked to speak to the Math Club and I was shocked when I walked into the room and saw one hundred women in front of me! There is also a concerted effort to strengthen connections among students in the same major. For instance, the Biology Department has established a seminar called the “Biology Sophomore-Senior Seminar.” This course promotes mentoring between seniors and sophomores in the context of career exploration from students at different points in their academic program in biology. This type of intentional mentoring, both with peers and those outside of Spelman, directly impacts the degree of academic excellence evident at the college.

There is also a strong expectation that students will engage in research. Most of the faculty at Spelman who have research labs have students working with them. Because we have a number of student research training programs, there is never a problem finding a laboratory research placement. Students gain experience in labs at Spelman, or at other institutions in the metropolitan Atlanta area such as the Morehouse School of Medicine, Emory University, or Georgia Institute of Technology.

The sizes of the classes at Spelman, on average, are kept to about twelve students; the student faculty ratio is 12:1. Students are able to get to know their professors, and many are mentored by them. However, a Spelman student typically has more than one mentor. They have student mentors; mentors who are already in industry or a NASA engineer for example, all of who keep in touch with their respective students. Many mentors are African-American women role models.

NEW INITIATIVES AND CONCLUSIONS

To summarize, the culture of academic excellence at Spelman is not only focused or limited to STEM success, but permeates the expectations of high achievement in general. For example, we have a high number of students obtaining Fulbright Scholarships; in the last few years we have had at least four Fulbrights per year. We also have a growing Study Abroad program; we send students to study abroad and we also have a number of international students coming to study at Spelman.

We have the intersection of the strengths of an HBCU and a women's college because along with Bennett College we are the only two HBCUs for women in the United States. We provide an academic framework that makes excellence a reality for students at Spelman by strengthening the connections among academic excellence, service learning, and leadership and community outreach. Barbara Whitten focused on the importance of outreach activities for women in physics, stating that, "it gives physics a face." When you can connect and relate to young girls in middle school and high school and provide research opportunities, then as undergraduates, they will see the connection between academic excellence and making a difference in the world beyond Spelman.

Some of our new STEM initiatives include the recently submitted proposal to the NSF, "Enhancing Global Research and Education in STEM at Spelman College." This program will focus on increasing STEM research opportunities abroad for our students. This initiative is aligned with our Quality Enhancement Plan (QEP), which we are developing as part of our Southern Association of Colleges and Schools (SACS) Reaffirmation of Accreditation. The goal of the QEP is to improve some aspect of undergraduate education, and the college's plan is to focus on internationalizing its curriculum.

Spelman is also the proud recipient of funding from the Department of Energy to establish the Massie Chair in Physics, focusing on research, environmental management and enhancement of the science curriculum. The entire physics department along with one member of our chemistry faculty are collaborating on this project.

In preparing tomorrow's scientists we are not only making certain that Spelman students excel and graduate in the sciences but we also prepare students to be able to work with others in an interdisciplinary and collaborative manner. Three examples of such projects that are funded by the NSF and NIH are:

1. **ASPIRE**—Advancing Spelman's Participation in Informatics Research Education. This is an interdisciplinary approach to conducting collaborative research that focuses on informatics and quantitative skills. (This project is funded by NSF, HBCU-UP.)

2. **ARTSI**—Advancing Robotics for Technology and Societal Impact; a collaborative education and research project that focuses on robotics for healthcare, the arts, and entrepreneurship. (This project is funded by NSF.)
3. **Health Disparities Scholars Program**—This program, funded by the NIH, prepares students for success in research related to the nature of health disparities in our society and interventions to reduce these disparities.

Such interdisciplinary curricular collaborations are important elements in developing cohesive academic programs in STEM—curricular programs that promote interdisciplinary thinking, problem solving, and research. One example of this at Spelman is the partnering of faculty in computer sciences and biology to develop a team taught bioinformatics course-team.

Finding the best path to providing a superb education in the sciences is tough work. But by having a diligent vision, working as a team and highlighting the importance of high academic achievement, an educational institution such as Spelman has set these standards for our students, and given them the research and curricular opportunities to reach their goals. Spelman College stands out as a prime example of this extraordinary accomplishment.



KATHIE OLSEN

National Science Foundation

Women in Science and Engineering: Exploring what aMAZEs Us

A. B. Carlson and K. L. Olsen, National Science Foundation

SUMMARY

Women in scientific and technical fields have made significant progress in the past several decades towards sharing equally with their male counterparts both in the conduct of research and education and in its leadership and administration. This includes inching towards equal remuneration and reward for equal effort and accomplishment. However, today's "glass ceiling" remains a real and stubborn barrier to achieving full equality. Despite our best efforts, we often find ourselves struggling through a maze of advice and good intentions without finding a clear path towards our goal. This paper examines a variety of attempts to document and understand the careers of women in science and engineering, provides some pertinent statistics and trends, and offers some pointers for women's success.

INTRODUCTION

The 1970s saw a surge of interest in the careers of women and in the concept of professional equality between the sexes. Since that time, innumerable books and articles have documented the status and progress of women in such traditionally male fields as science and engineering (S&E). Despite much progress, even a brief survey of the past decade produces a multitude of studies and reports that continue to document disparities in achievement and recognition. Without the diversity that we know improves our overall competitiveness, we hold ourselves back from optimal progress in these fields that hold the answers to key challenges facing this nation and the globe.

The National Research Council (NRC) is one group that has extensively studied the nature of women's careers, in particular through its Committee on Women in Science, Engineering and Medicine, and also through such bodies as the Committee on Science, Engineering and Public Policy. Three prominent NRC reports [1-3] span nearly a decade of research and thoroughly document the situation of women in academic science, engineering and medical careers. The federal agencies, especially but not limited to the National Science Foundation (NSF) and the National Institutes of Health (NIH), have also devoted significant resources to the issue and its resolution, with multiple programs and initiatives to encourage the development of women's careers in S&E

[4 – 9]. Others have published studies in eminent research journals [10], books [11], and as government sponsored studies and commissions [12-13]. The following descriptions of today's S&E research workforce, as well as many of the strategies recommended, are gleaned largely from these resources.

WHERE ARE WE?

Women who are now at senior levels in careers as scientists or engineers may well have been explicitly discouraged when young, as both authors were, from pursuing careers in math or science. Those days of explicit bias against women in technical fields are fortunately, for the most part, behind us. Yet bias, in its more insidious form—unconscious bias—is alive and well and affects not just how others perceive us but how we see ourselves. Unconscious bias is in force across the career platform, from a child's belief that “girls don't like math” to eminent committees and panels that may fail to question the dearth of female recipients of science's top grants or honors. What was true in 1970 [14] remained true in 1999 [15]; despite our best efforts—both men and women are significantly more likely to rank a perceived man higher than a perceived woman, using identical resumes. Alternatively, when sex is factored in, studies show that women have to be more accomplished in order to compete [10, 16]. Far from discrimination being intentional, our history and culture conspire against us to such a degree that it takes conscious effort and vigilance to root out our unconscious biases. Until the situation was corrected in 2007, after significant media attention, a Google search on “she invented” would receive the automatic prompt; “Did you mean ‘he invented?’” Frustrated by this, one of the authors wanted to see if there was a trend and typed in “she discovered,” “she calculated,” “she analyzed,” and “she led,” only to be prompted each time by the insidious; “Did you mean ‘he...?’” The author finally typed in; “She cried.” Not surprising to us, there was no corresponding question about whether she meant “he cried.”

We have made progress at the high school level in encouraging girls. Females are slightly more likely to take advanced placement trigonometry or algebra III and precalculus, and only slightly less likely to take calculus, in high school [17]. Female high school students are also more likely to study advanced placement biology and chemistry, though they are less likely to study physics and significantly less likely to study engineering [17]. Additionally, the percentage of women enrolled in college has exceeded the percentage of men since the late 1970's [1]. However, the relative advantage women may have in their early educational years becomes less pronounced as they progress through the educational pipeline or pursue careers. In 1972, there

were no S&E graduate programs with a majority of females. In 2001, women were in the majority in health fields, biological sciences, psychology, and social sciences graduate programs, although they remained 25% or less in engineering, computer sciences and physical sciences [17]. But, the faculty they work with in either setting remains largely male. In 2002, 64% of full-time faculty members in the US were male while 90% of full professors in science and engineering were male, and the gap in the US between the percentage of tenured men and the percentage of tenured women had not changed in 30 years [18]. While they have achieved near equal representation in the overall workforce, women are significantly underrepresented in the S&E workforce [19]. Female academic researchers, at least in the life sciences, also appear to be generally less satisfied with their careers than their male counterparts [20]. One possible explanation could be the persistent lag in salaries [1, 17]. It also appears to be especially difficult for doctoral scientists and engineers who are female to juggle the demands of career and family, considering the drop in the percentage of full time employed that have children at home as compared to their male counterparts (who are slightly more likely to be employed full time if they have children in the home) [1].

WHERE DO WE GO FROM HERE?

Knowing the situation—acknowledging both our strong progress and the remaining challenges—is important. Knowledge is power. But, where do we go from here? What strategies should we, as individuals and as institutions, take to address the remaining challenges in achieving the full potential of the US workforce, for ourselves and for our daughters and sons?

A science or engineering degree and career are very desirable things to have. Public perceptions of scientists and engineers are very favorable, salaries are high, and unemployment rates are low [17]. Even in times of economic uncertainty, S&E jobs will continue to be in demand, especially in the energy sector [17]. This message needs to get out to girls as well as boys, and to their parents and teachers, together with what they need to do to secure such a future. Although as many as 25-30% of entering college students intend to major in S&E fields, fewer than 50% complete such a degree within a 5-year period [21]. Many enter college inadequately prepared to master the science, engineering or mathematics curriculum. The messages that are essential to shape the choices of girls as well as boys must get to them while they are still young enough to prepare. In particular, we must consciously fight the cultural message that girls are not good at math and science—it has no place in our future! And, because there are fewer, we need to give extra attention to exposing girls to female role models

in these fields. We need to be role models and mentors ourselves. Choices are shaped by what children see, and hear, and find familiar. We can and should manage these messages.

We can also manage our own careers. We can learn from our peers and from our mentors how to maximize our options. Catalyst is an organization that, since 1962, has worked to expand opportunities for women in business. In 1996, Catalyst conducted the study *Women in Corporate Leadership: Progress and Prospects*, a survey of women and CEOs in Fortune 1000 companies that examined success factors employed by women and the perceived barriers to their advancement [22]. This survey investigated the strategies that women use to overcome barriers in the workplace, such as seeking challenging assignments, finding an influential mentor, gaining diverse experience, and initiating discussions regarding career aspirations. These strategies were ranked by successful career women in order of importance or criticality in their own success. It is perhaps no surprise that these women ranked “consistently exceed performance expectations” as the #1 strategy for success. There are no shortcuts! But, the #2 strategy was a bit surprising; “develop a style that men are comfortable with.” Apparently institutional culture is still more entrenched than some of us would like to believe! We can play the game and succeed, but we do need to know the score.

However, individual action is not the full answer. Institutions can and should change, and funding organizations have a responsibility to encourage such change. Both NSF and NIH have strong programs to foster institutional transformation in ways that enhance and promote the careers of women, other underrepresented minorities in S&E, and men.

At the National Science Foundation, ADVANCE is the flagship program to recruit and retain women in science and engineering careers within universities. The goal of the ADVANCE program is to develop systemic approaches to increase the representation and advancement of women in academic science and engineering careers, thereby contributing to the development of a more diverse S&E workforce. Since 2001, the NSF has invested over \$130M to support ADVANCE projects at more than one-hundred institutions of higher education and not-for-profit organizations in forty-one states, the District of Columbia, and Puerto Rico. Our results have shown that these grants have been good for the institution as a whole, not just for its women. Current ADVANCE grants are awarded in one of three categories:

1. Institutional Transformation grants include innovative systemic organizational approaches to transform institutions of higher education in ways that will increase the participation and advancement of women in science, technology, engineering, and mathematics (STEM) academic careers. These awards support comprehensive programs for institution-wide change.

2. Institutional Transformation – Catalyst grants support institutional self-assessment activities, such as basic data collection and analysis and policy review, in order to identify specific issues in the recruitment, retention and promotion of women faculty in STEM academics within their institution of higher education. This type of work is fundamental for institutions that plan to undertake institutional transformation.
3. Partnerships for Adaptation, Implementation, and Dissemination (PAID) awards focus on one institution or organization, or they may be a partnership between several institutions and/or organizations. PAID projects can focus on all STEM disciplines, several disciplines, or only one discipline, including the social and behavioral sciences. PAID awards support activities such as adaptation and implementation of materials, tools, research, and practices; Dissemination and diffusion to the appropriate audiences; and scientific research designed to advance understanding of gender in the STEM academic workforce.

Additionally, at the NSF many disciplinary programs have components that help to promote and enhance career opportunities for women in science and engineering. For example, the NSF Earth Sciences Postdoctoral Fellowships Program recently announced an important change in the award conditions that will support fellows who have a child or adopt during the award period. Fellows may request a no-cost extension for parental leave for the birth or adoption of children, and they may request to use two months of their stipend for paid parental leave.

Out of concern for the future of its own constituency and in response to the National Research Council report *Beyond Bias and Barriers* [2], the NIH launched its Women in Biomedical Careers Initiative. In October 2009 the initiative announced the funding of 14 grants focusing on factors that influence the careers of women in biomedical and behavioral science and engineering. The new grants, which are expected to total \$16.8 million over four years, will examine many influences on women's career choices such as family and economic factors, institutional environments and broader social and cultural issues. Topics range from the role mentoring and funding support play throughout women's academic careers to the impact of family-friendly policies in retaining women in the scientific workforce. The career paths of underrepresented and financially disadvantaged women will also be examined.

Between individual action and organizational transformation, the challenge of eliminating barriers and achieving workforce equality is one that we can achieve, not just for women, but for all underrepresented minorities in S&E, and for men. We know the path; we only need the energy and determination to follow it, because we know this is critical for our future prosperity and quality of life.

CONCLUSION

In the quest for full inclusion and the equal contribution of women in the sciences and engineering, we can feel like rats in a maze—continually trying first one direction and then another, without making the progress we foresee. But a look at the achievements of the past few decades does show consistent progress and defines the challenges that remain in ways that point towards the solutions. Through a combination of individual action and institutional transformation, and with the support of funding agencies as well as all our colleagues and mentors (female and male), we know the path towards full equality. All we need is the energy and determination to follow it and the patience to accept that change that is fundamental and deep can also be inherently slow. At times, this quest has seemed almost impossible, but, as Arthur C. Clark reminds us, “the only way to test the limits of the possible is to go beyond them, into the impossible.”

Let’s go!

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Chair: Colleen Hartman, *George Washington University, Senior Science Advisor, Science Mission Directorate, NASA Headquarters.*



Panelists: Loretta Hidalgo Whitesides, *Executive Director, Yuri's Night* and Renetta Tull, *University of Maryland Baltimore County*



Panelists: Kathleen Flint, *National Postdoctoral Association*; Ron Polidan, *Northrop Grumman Aerospace Systems*; Orlando Figueroa, *NASA/GSFC*

To Boldly Go: Paths to Non-Academic Careers Panel Summary

P A N E L I S T S

Colleen Hartman, NASA HQ; Loretta Hidalgo, Whitesides;
Kathleen Flint, National Postdoctoral Association; Renetta Tull, University of Maryland
Baltimore County; Ron Polidan, Northrop Grumman, Aerospace Systems;
Orlando Figueroa, NASA/GSFC

To Boldly Go: Paths to Non-Academic Careers Panel Summary

Chair: **Colleen Hartman** Panelists: **Ron Polidan, Orlando Figueroa, Loretta Hidalgo Whitesides, Renetta Tull, Kathleen Flint**

Chair's Introduction: *A doctorate in astronomy or a related field opens the door to many career options, of which research is only one. How do you navigate the path to these careers and how does your doctorate help? Many graduate students want to emulate their favorite professor and one day become professors at a major university themselves. However, the number of jobs at university is not adequate to allow every graduate student to become a professor. In addition, every PhD candidate may not want to become a university professor. Given these multiple options, it is wise to paraphrase Niels Bohr: "We are all agreed that your path is crazy: the question that divides us is whether it is crazy enough to have a chance of being the correct path." For those PhD professionals who do not want to become professors, how do they find their own bold path?*

Five outstanding panel members shared their personal stories, proving that there is no one path to a successful, fulfilling career in science — there are many exciting, bold paths. Most panelists repeated one of the most compelling points: keep your heart and mind open to opportunities; keep your skill set high; do a great job; and find a network of colleagues with whom to connect and share your excitement.

Although summaries of this panel conversation are pale imitations of the "real" experience, they will give readers a flavor of the panel members' remarks. The webcast of this discussion is available for viewing on the conference website along with the speakers' complete biographies.

PANELISTS REMARKS

Dr. Ron Polidan is the Civil Systems Director of Advanced Systems in the Space Systems Division of Northrop Grumman Aerospace Systems. Ron has experience in three major areas of activity for those with science doctorates: academia, government, and private industry.

I would like to put my comments into context and let you know my background. I trained as a research astronomer – for twelve years I worked in academia as a soft money scientist successfully writing proposals and publishing papers. Then I spent fourteen years as a NASA GSFC Civil Servant. During the first half of my years at GSFC, I was a research scientist, project scientist, evolving into a budding technologist. During the second half of my time in Center management, I was Assistant Director for Technology for Space Science (Code 600) eventually becoming GSFC Chief Technologist. I think I was the first and only person to hold a Chief Technologist position without the benefit

of even a single engineering course. I think I did a decent job while in the position. Now, it has been five years and counting at Northrop Grumman, where I have been Astrophysics Line of Business Manager for two years, Chief Architect for three years (also the only person to hold the title without the benefit of an engineering course), and Advanced Systems Director for the past few months.

So a simplified summary of my approach is: research using spacecraft leads to supporting spacecraft which develops technology interest (why can't we do things better), which leads to technology management, then just management. My career has encompassed all three of our traditional career paths: academia, government, and industry.

I would like to bring up a cultural issue: astronomers in industry are not failed academics; you do not have to talk to us slowly using monosyllables. We are your peers; we are intelligent, innovative, and creative people who have chosen industry for good reasons and we do contribute to the advancement of science. I have not seen significant differences in the quality of my academic, government, or industry colleagues. Embracing diversity means not stereotyping people who work in industry as your inferiors. I am also working within industry to have it drop its stereotypes of academia and government.

My varied career was not planned. I took advantage of good but unexpected opportunities to broaden my perspective and my skills and always sought to expand my horizons. Diversity and change are good; they truly help you grow. Look for and take advantage of good opportunities as they arise—do not be slave to some master plan that may never happen. Do not think that no change is a safe path.

All my jobs have had their challenges and the associated rewards for overcoming those challenges; each job has had its fulfilling highs and depressing lows. In looking back—I



Conference participants talking with panel member Ron Polidan.

miss the research, but I also miss much of the support and development that I did working for NASA, and should I move on from my current job I will certainly miss much of what I am doing now. All my jobs have been rewarding.

The key for me was that in each of my jobs I felt I was having an impact, I was making a difference—through scientific discovery,

technology development, managing people and missions, and certainly looking over the horizon and shaping what will be waiting for us in the future.

Choose jobs with challenges: Keep your eyes open, look forward, broaden your vision and skills, look for opportunities, assess them and take advantage of the good ones as they arise—be daring, embrace change and diversity, but understand that there is uncertainty in all things, especially in not changing. As you go forward try to “boldly go” forward in your career.

***Orlando Figueroa** is Director, Applied Engineering and Technology at NASA/GSFC. As Mars Program Director at NASA Headquarters, he was responsible for rebuilding the Mars Program, including the wildly successful Mars Exploration Rovers, Spirit and Opportunity.*

First, I'd like to put my background into context. I was born in Puerto Rico. There, you are either born a NASA freak or you become one. Are people really born NASA freaks? Yes, I was one! I was born and raised in a poor neighborhood and when you are in such an environment, you develop survival skills very early on. You have antennae to look for threats and problems and to give you advance warning. I learned to adapt that early skill to my work at NASA as an engineer of systems. My wonderful mentors at work were key to helping me bridge the gap and make the leap.

Puerto Rico, like in many of the Hispanic and Latino cultures, has a matriarchal male dominated society where men need to speak louder to make their points, especially if there is a threat that women are networking and conspiring to fix things [laughter from audience]. I bring this up because, we appreciated the role women play, but never quite gave them the opportunity to truly get ahead of us (the men).

In the 1970's, the USA expected for the Hispanic/Latin American population to double in number within 25 years, and that there would be an need for engineers.

Federal and non-federal agencies were looking for Hispanic engineers wherever they could find them. Sadly at the time (although lucky for me), there were only a couple of accredited engineering schools in the Nation (including Puerto Rico), and the University of Puerto Rico in Mayaguez was one of them. I applied and interviewed with all of the NASA Centers that visited. I was lucky to be made an early offer by the NASA Goddard Space Flight Center. I was also very lucky to join a group that truly believed in mentorship; they embraced the concept of being a mentor by making certain that I had the support system to succeed. Without their unselfish mentorship, I wouldn't have gotten to where I am now.



Colleen Hartman and Orlando Figueroa answer participants' questions.

There were very few women working at NASA at that time. The popular belief that there would be “seven” women for every man certainly didn’t apply at Goddard; not because of ill intended reasons, but because the focus wasn’t there. In the group I was in we did manage to hire a very talented woman engineer. I wondered however, why did she seem to

feel so isolated. She often left messages on the blackboard, and there was a message she left that I still remember: “For every ten “atta boys“atta boys,” there is “atta girl.” Women (in her eyes) perceived that they had to work ten times as hard to prove themselves. As a minority, I can relate to that belief better than most, because to us that perception becomes a deeply rooted fact.

Today we have progressed, and my views have also changed with my growing experience. My definition of diversity is different today from that which I began with. I believe that to make true progress, there has to be a committed intention. A big step has to be taken in order to make a change, in order to be conscious of the biases. I have found that constantly asking oneself a few questions reinforces this necessary change. Does it look like equity? Is this a diverse group, reaching out to all groups in an inclusive and fair fashion? We have to ask ourselves these questions. Everywhere I go now I evaluate these quantities: equity and diversity. By being very conscious and asking explicit questions about our level of inclusiveness, we can continue to make real progress.

Loretta Hidalgo Whitesides is a space explorer who was featured in the 3D IMAX movie “Aliens of the Deep,” co-founder of Yuri’s Night, and blogger for Wired Science.

I too, like Dr. Lily McNair from Spellman College who spoke yesterday, wanted to fly into space ever since I was a little girl. I worked hard, got my BS in biology from Stanford, worked a few years at NASA and then went back to Caltech to get a PhD. While I was there, I got very involved with outreach and helped launch an annual worldwide space event. My advisor would ask me questions like “you really seem to enjoy outreach, are you sure you don’t want to do that and not research” and my ego answered- “no of course not! I want to finish my PhD!” and then promise to work harder in lab. At the time, it seemed like the only path was to try to be just like my professors.

As things got harder for me in graduate school, it became clear that I was going to have to decide between the “traditional” science route and taking the road less travelled. I was terrified. I wanted desperately to try something alternative, but with few role models, I had no idea what to do or how I would feed myself. Through a lot of soul searching, coaching and expert mentoring, I chose the road less traveled. I left my PhD program after two-and-a-half years and set off to make the difference in the world that called to me.

I received a grant from Caltech to work on some of my space outreach ideas and projects during my first year out (that helped ease the transition a lot!). The following June I spent three weeks as the head counselor at the Sally Ride Science Camp when I got invited to join an expedition with Hollywood Director James Cameron to spend two months at sea and dive in a deep sea submersible to the bottom of the ocean to film a 3D IMAX movie called “Aliens of the Deep.”



“Aliens of the Deep” filming. Pan Conrad of GSFC in lower left.

The following spring I started working for the X PRIZE Foundation—that gave ten million dollars to the first private suborbital human spaceship. It was a great place to work. Fast paced, innovative, and free-form! The head of the organization, Peter Diamandis, was a real visionary too. He was an important mentor to me.



X Prize

I have been flying with Zero Gravity for the past five years. It is lot of fun and again allows me to interact with the customers, answer their technical questions and get them excited to explore a whole new experience. Through a grant from Northrop Grumman we also fly math and science teachers from middle school and high school as a thank you for their service to the country. It is a really great program that starts to honor teachers as heroes and gives smart people more incentives to go into teaching. So if you know a great teacher, tell them to Google it and apply!

I also took on being a Wired Science blogger for a year. It was an incredible opportunity to write, express ideas, educate people about science and write about the latest and greatest science news. I really saw how few people in journalism really know much about science and how valuable it is to have people with scientific training. Much of what the public learns about science is mediated through the media and if you can help them get it right, but still have it be sexy and interesting, you will have a great career in media. I wish more scientists would do that!

Go where there is no trail and make your own non-academic trail. I invite you to go follow your dreams and help others to follow theirs.



Start-up “Zero Gravity Corporation” has Loretta in zero G.

Dr. Renetta Garrison Tull is the Assistant Dean of Graduate Student Development at the University of Maryland Baltimore County (UMBC), an Honors University in Maryland and the Director of PROMISE — Maryland’s Alliance for Graduate Education and the Professoriate, which is an alliance of the three public research universities in Maryland. She is also a national coach and mentor.

I have a job that did not exist five years ago. I am an engineer and went to Howard University and then Northwestern University, receiving a PhD in Speech Science, which is a combination of Speech Pathology and the signal processing of electrical engineering. I had a postdoc at the University of Wisconsin-Madison and became an assistant professor. After a couple of years, I had the two-body problem: my husband wanted to start a high-tech business in Maryland and at that time, there was no faculty position in my field at Maryland. So I worked with my husband for a few years as an entrepreneur, but I kept in touch with my mentors to look for new opportunities. One of my mentors had a grant and she asked me to be a Director for her program. I then participated in the national search for a Director for Maryland’s Alliance for Graduate Education and the Professoriate (AGEP), a program of the National Science Foundation. I was responsible for developing a program from scratch designed to increase the number of diverse graduates in STEM.

Throughout my graduate and undergraduate careers, I did a lot of mentoring. As an undergraduate, I mentored the freshman and sophomores. I also volunteered for duty on committees; eventually I chaired committees. My advice to you is to build a reputation as the ‘go-to’ person, the one who can actually get things done. Positions such as Dean and Provost require a lot of prior experience, so set out to get it. Most of the things that I am doing now are dealing with graduate students and postdocs and helping them with their careers, so all of my prior experience helps.

Keep in touch with your mentors. If there is a position that you are interested in, ask the people in a similar position to be a mentor for you. I asked my mentors to put me on certain committees with people on them from whom I could learn new skills. Now, I sell ideas to policy makers, write a lot of grants and speak nationally. In academic administration, it is very important that you know your job and that you can perform.

I was given excellent advice from the dean of a graduate school with whom I had breakfast at this conference. She said, “Know what kind of person you are. Are you a start-up person or a turn-around person? Or are you a maintenance person? Understand your style.” It helped me to know my own style and to know my strengths and weaknesses. Build on your strength and hire someone to help you on your weaknesses. I now work with professors in other fields to help them get grants. I work on things that

go beyond my university. Often I have to work through many opinions and personalities. Through mentoring and marketing, let people know you are interested in a particular field and ask them to keep you in mind if something comes up. Your network of contacts will help you and I wish you the best of luck.

***Dr. Kathleen Flint** is Project Manager at the National Postdoctoral Association (NPA), where she manages the Advancement of Women in Academic Science and Engineering Careers (ADVANCE) program funded by NSF.*

I quit a postdoc in Hawaii and went into policy. In my current, non-academic career path, I enjoy many parts of my job. How do you go about deciding upon a career path after your degree? Think about the language that you want to speak every day and let that help you select your job. As Project Manager for the national postdoc association, I am very close to the postdoctoral community and advocate for it. There are a number of NSF paid grants that promote postdocs in aiding them in making the shift from postdoc to faculty. I have been able to use my knowledge and skills that would not be used in research. When I am asked ‘do you miss astronomy?’ The answer would be ‘of course yes.’ But I continued to do some teaching, and get involved in many ways. There are growing opportunities in non-research areas.

Sometimes I am asked: if you are not doing research did you really need a PhD? I think this is a personal answer. Having a PhD degree is important. Did I need a postdoc since I did not stay in research? I wasn’t sure if I needed it, but I felt I owned it to myself, and I needed time to decide.

It can be a nice transition, no matter what you do next. When asked: ‘if you have a good career advice, what is it?’ Someone once said to me: ‘when you think about what you want to be when you go to work, think of yourself what you want to be wearing every day.’ If you think about the way you want to dress is linked to your picture about yourself, then this is another piece of the puzzle.

QUESTIONS FROM THE AUDIENCE

Comment from Dr. Nancy Roman: Many astronomers think that the only interesting thing to do in astronomy is research in the academic setting. It might even be said that many in the field think that anything except academic research is beneath them. But in my career, I found I could do more good for astronomy with my NASA job than with a research job. In fact, some of my own accomplishments for which I am most proud were done while serving in the federal government, for instance, providing funds for many academic researchers. This panel has aptly brought out the contributions you might make in jobs such as the one I had at NASA Headquarters.

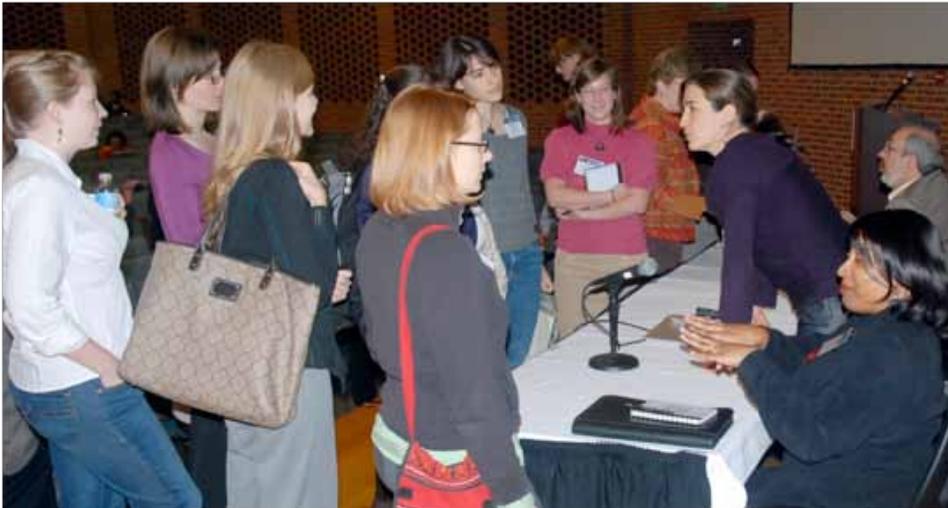
Audience Member: *What kind of environment did you find in the aerospace industry?*

RP: Industry has a college campus-like environment, very collegial, with about 40% women: there are some women above me in our organizational hierarchy and some below. I have found that if you do well, you can rise quickly at Northrop Grumman.

Audience Member: *How do we share these kinds of opportunities with our students? We need to tell them that there are opportunities out there, but how do we do it?*

RT: At UMBC, we invite students to come to a meeting with people from different companies and industries; places to look for people who are doing alternative careers. I also suggest that you look at AAS, they have a professional astronomer's network. Note that the AAS has a network of mentors and people are encouraged to talk with them.

Note: *Due to time constraints, there was only time for two recorded interchanges with the audience, although all panel members were deluged with additional questions.*



Panel members fielding questions from an enthusiastic audience.

ACKNOWLEDGEMENTS

Panel Chair Colleen Hartman would like to thank Dara Norman, Blake Bullock, and Ann Hornschemeier for their help in setting up this panel and Nelly Mouawad for taking valuable real-time notes.



ELIZABETH FREELAND

Department of Physics, Washington University in St. Louis

Managing and Supporting Career Breaks in the Sciences

Elizabeth D. Freeland, Department of Physics, Washington University in St. Louis

SUMMARY

Career breaks in science can occur for a variety of reasons and it is difficult to recover from them. If we want a strong and diverse pool of scientists, it is wasteful to exclude people who have a small gap in their work history. To make such recoveries easier, career breaks should be accepted and supported. I first define a career break, discuss how one might occur, and discuss how accepting them can benefit science. After an overview of my own experience, I discuss how others might successfully take a break. I conclude with suggestions for both individuals and institutions on how to promote flexible careers.

INTRODUCTION

One important goal of the scientific community is to foster and support the creation of a diverse pool of exceptional scientists. In order to do this, we, as members of this community, must make sure we are not arbitrarily closing doors on quality scientists. Unfortunately, we do this both to people who have a true break from science and those who work part-time.

For the purpose of this article, a career break is defined as a period of time with reduced or zero hours in a scientific job. Although working part-time is definitely work, it is generally not valued by full-time academics or researchers [1], so I include it in my definition of a break. Most commonly we associate career breaks with the caretaking of infants and toddlers. Dual-career couples may also come to mind, e.g. a spouse who takes a part-time position “temporarily.” However, there are other events that can cause breaks, such as elder or spouse care [2], military service, or internships in public policy or outreach. Should we lose a talented young person because they quit working full-time to care for a spouse with a terminal illness? Everyone I know would say, “Of course not!” And yet our system of employment is not designed to accommodate such events. Surely this talented young person would “know people” who would help. But is our system of science based on “who you know,” or do we strive for the ideal of meritocracy? If we desire the latter, then we need to build that into our system.

By creating a system that minimizes bias against full- and part-time breaks, we open up flexibility for a number of situations. Breaks can ease work-family tension, which is a concern of graduate students and a challenge for the majority of assistant professors [3, 4]. Dual-career couples, which disproportionately involve female scientists [5, 6],

may be better able to survive the post-doc years. Segmentation of the work force—the nearly permanent separation between tenure-track and adjunct faculty which tends to perpetuate gender imbalance [1]—may be ameliorated. Flexibility in career paths can allow for cross-cultivation of science disciplines and may help to increase diversity. Finally, there is a glaring need for better science education in the U.S. and better communication with funding agencies and government policy makers. Accepting career breaks in the form of internships could help to strengthen ties between those who focus on science policy, outreach and education and those who focus on cutting-edge research.

The scientific community could greatly benefit from being more open to people who take career breaks. Unfortunately, because of the difficulty in surviving career breaks and the stigma that surrounds them, little is known about the problems people encounter or their individual solutions¹. To begin then, I give a personal perspective via a brief description of my own experience [9]. This motivates my advice for how to take a break, some comments on obtaining grant funding, and my advice to individuals and institutions on how to support scientists with career breaks.

MY EXPERIENCE

My break was unintentional. As a graduate student, the faculty around me consisted of men with children and stay-at-home wives, unmarried women, and married women who had children late in life. They worked evenings, weekends and, proudly, through holidays; many were divorced. This was not a very encouraging situation for someone who wanted a family. It was clearly understood by the graduate students that the suggestion of any path other than complete dedication to research would be seen as “not serious,” so work-family discussion with faculty were nearly non-existent. I liked physics; but I was not so sure about physicists or the physics life. My husband wanted to accept a post-doc position on Long Island. We naively thought I would be able to find a position at an undergraduate institution in the greater New York-New Jersey-Connecticut area² thereby keeping our family together. That did not work out and I ended up “out of physics.”

¹Exceptions to this are a booklet published by the U.K’s Institute of Physics and an article I wrote in 2004 [7, 8]. In addition, an NSF-funded study on career breaks has just been started by C. Mavriplis and R. Heller at George Washington University; www.student.seas.gwu.edu/forward/mindthegap/.

²There is a myth that teaching is more compatible with family than research. The pressures are indeed different, but the hours are almost the same [1] and the pay is decidedly less.

Once outside of science, I was cut off from it. Unable to find a job at an undergraduate institution, I spent time working in other areas. It was refreshing to feel that I had valued skills, to interact with professionals who had lives beyond work, and to feel it was normal to talk about family and children. The experience was a breath of fresh air.

My return to science began with our move to Chicago, a science-rich area. How to return was an open question, and there was no information to answer it [8]. I still wanted a career at an undergraduate institution. I needed teaching experience and research I could sustain at such an institution. In addition, we wanted to start a family, and over the next few years we had two children. To restart my career, I did what seemed reasonable. I obtained a part-time teaching position and began looking for summer research projects. I wrote a number of physicists in the area asking about projects and offering to find my own funding. As a result, I began working with staff in the theory department at Fermilab. Not only was I returning from a break, now I was also changing fields from condensed matter to high-energy physics.

Funding was nearly impossible to get. My part-time status made me ineligible for every grant in the U.S. except one, the American Association of University Women's (AAUW) American Fellowship. I juggled childcare, teaching, and learning a new field until I was ready to apply for this one-year, full-time fellowship. Receiving the grant was a major turning point and the beginning of a real chance at returning to science. The Blewett Scholarship came into existence that year; I applied for and received it as well. These grants provided two years of daycare, helping me bridge the gap until both my children were in school full-time.

Two years of research experience was not enough to be competitive for post-doc positions in my new field, and none of the very few full-time teaching jobs advertised had resulted in a job. Suspending my research would have cost me all the ground I had gained, so this was not an option. My family had the financial resources to allow me to work full-time while only bringing in the salary of a part-time teaching position. Given the dearth of programs for re-entry and retraining, I knew this would be a likely scenario at some point. Nevertheless, it was a very difficult time for me. People assume that "if you are good enough" you will get paid. When working for free it is almost inevitable that you, and those around you, will undervalue your skills and contributions.

Recently, I obtained a one-year post doc position. I spend every other week in a city six hours away from my family, but I enjoy the work and the intangible benefits of being paid. The journey is not yet over, but the closer I get to a mainstream career the easier it becomes.

Has hard work paid off? Yes and no. I have certainly worked hard to put a career together. But, I was also lucky. Some would prefer to say I had opportunities—opportunities for part-time jobs and research projects because I lived in Chicago; the opportunity to apply for funding via AAUW and later the Blewett; the financial resources, or opportunity, to continue my research through a period of no funding. These opportunities are not available to everyone but, as I discuss in Sec. 5 that can be changed.³

HOW TO TAKE A BREAK

See the conference website for a more detailed list of suggestions and points to consider.

STEP 0: Think it through. Get a mentor. Think it through again.

Think about your career goals, your personal goals, and why a break would benefit you. Consider what resources you have financially, personally, and within the scientific community. Any post-doc experience will greatly expand your options later. If the break is for children, ask yourself what it means for you to be a good parent. Being a good parent seems to be highly correlated with being a happy parent, and almost negligibly correlated with any particular action we take. Talk with other parents who are scientists, especially those who are in a situation similar to your own or one to which you aspire. Get a mentor. A thesis advisor, boss, or project PI is not necessarily a mentor. A mentor does not have to be in your subfield or department; it is sometimes beneficial if they are not. A mentor needs to be someone who can accept you as a scientist and the career paths you are considering, someone who can help you see the big picture and suggest options you may not have considered. It may also be helpful to have more than one mentor. A scientist in your field can advise you on the particulars of that research. Someone in a different field may be more open to your career questions and have a different perspective on options.

STEP 1: Plan your break.

While it is unlikely that you will stick to this plan, thinking it through will make you better able to take advantage of opportunities as they arise and overcome the inevitable glitches. It is also useful to have a timeline for your return and goals along the way. For

³In Peggy McIntosh's talk at this conference, *Unearned Advantage and Disadvantage as Work Impediments*, she pointed out that what I am hinting at is the existence of "privilege." I agree with her, noting that men are not eligible for either of the grants I was awarded.

a complete break, your goals may be to speak to your mentor regularly, read certain journal articles, and attend a career workshop.⁴ If you are working part-time you will have more substantial goals. In either case, having goals will keep you on track.

STEP 2: Keep in touch!

The presence of the internet has greatly simplified this. Communicate with your mentor(s) on a regular basis. They can remind you of your goals and help you create new ones as circumstances evolve. Many journal articles are available on-line now. If you can only access them via an institution subscription, see if a colleague can help you with this by making you a department “visitor.” Archived videos of seminars, colloquia, and workshops are also increasingly available. Attending a seminar at a local institution can help you feel connected to the scientific community. Attending a career workshop can be a good way of jumping back in and many will cover costs partially or fully. Remember, grant and job applications often expect three letters of recommendation. Keeping in touch with your references or establishing new ones is important.

STEP 3: Look for opportunities and don't take “no” for an answer.

Brainstorm with your mentors to think of opportunities for jobs and grants.⁵ Do not assume that you are ineligible for a grant or not qualified for a particular job. Ask, and if the answer is negative consider asking someone else. At times I have certainly taken “no” for an answer, assumed I was not qualified, or given up too early. It is not always as easy as it sounds; nevertheless, keep at it and keep getting better. Remember there are people out there who want you to succeed. If the people around you are negative, find new people.

A FEW WORDS ABOUT GRANTS

The bad news is that most grants require “full-time institutional affiliation” at the time of application.⁶ Wording such as “applicant must be within five years of their Ph.D.,” appears in most junior-scientist grants;⁷ and year-long grants are short even for very experienced researchers. The good news is that some countries have re-entry grants,

⁴Many NSF ADVANCE institutional-grant recipients offer career workshops and often with subsidized travel and registration fees. To have time to implement what you learn, plan on attending six to twelve months before you want to return to full-time work.

⁵Mentors are not responsible for getting you a job. In some cases, it may be appropriate for them to write a letter of recommendation. But, their ability to help you find opportunities, think of new paths, and offer moral support is what makes them invaluable.

⁶Current exceptions in the U.S. are AAUW fellowships and the Blewett scholarship.

⁷Current exceptions in the U.S. are the Sloan Foundation and AAUW grants.

although most are restricted to women. For more information see Ref. [10]. Keep in mind that new grants appear and grant wording does change.

As someone returning from a break, it is likely that you will need institutional affiliation during the tenure of the grant. In addition, support via resources such as office space, lab space, and materials will likely be expected. Grant-giving institutions may also want to see evidence of a mentoring or collaborative relationship. This is where “keeping in touch” during your break becomes important.

The most practical advice I can give about obtaining a grant is to get help. If you can, attend a career workshop or grant writing seminar. There are also excellent resources online. Two of my favorites are *Murder Most Foul: How Not to Kill a Grant Application* [11] and *The Beauty of Outlines* [12]. A poster presentation by the NSF at this conference humorously provides some good, institution-specific advice.

HOW INDIVIDUALS AND INSTITUTIONS CAN HELP

“Culture eats strategy for breakfast.” —the 2006 “war room” of the Ford Motor Co.

Individuals can help by talking with students, colleagues, and mentors about work-family concerns and other issues surrounding career choices. Graduate students in particular only see one small corner of the world; situations they experience may be common but not universal. Reference [13] lists places to find articles to jump-start conversations. Invite someone who is familiar with these topics to give a department seminar. Encourage students and senior scientists to participate in career and diversity workshops.⁸ Encourage mentoring.

Institutions have begun to make it easier to take a break within the institutional structure by the creation and promotion of parental-leave and tenure-clock-stopping policies. Continuing these efforts and expanding the focus to child-care and the circumstances of graduate students and post-docs will help. Make part-time work legitimate in the culture of science. It is a logical way to return to a full-time career, and even cutting edge research groups do have places where a part-time researcher can contribute. In addition to promoting the idea of part-time positions, make sure that part-time work is not seen as a negative for full-time job applications. Do not look upon multiple post-doc or soft money positions as a bad omen. These may simply be the way a person has juggled a complex personal life, e.g. dual-career couples.

⁸“White males” should be particularly encouraged to attend. Changing a culture is hard work; we need everyone to pitch in.

Remove “full-time, institutional affiliation” as a criterion for grant eligibility at the time of application. Requiring such status during the grant tenure is a separate issue. For an example, see the AAUW American Fellowship. At a minimum, make it clear that petitions for eligibility are acceptable. Relax the time constraints on grants and programs targeting “junior” researchers. The wording of the Sloan Research Fellowship provides a starting point, where candidates may: “be no more than six years from completion of the most recent Ph.D. . . unless special circumstances such as military service, a change of field, or child rearing are involved. . . If any of the above circumstances apply, the nomination letter should provide a clear explanation.”

CONCLUSION

To do the best science, we need the best people, and they may not all follow a conventional career path. Simple procedural changes can make the employment system in science far less biased against career breaks. Changes in our perception of part-time workers may be more difficult to achieve, but are needed as well. Evaluating people based on their experience, ability, and promise, not on how well they have stuck to the conventional path, will improve science for everyone.

ACKNOWLEDGEMENTS

I would like to thank some of the many people who have helped me along in my career-break adventure: my husband and children who live through the ups and downs; my mother who has babysat above and beyond the call of duty; and my mentors Maria Klawe, Andreas Kronfeld, and Debbie Harris all of whom have been irreplaceable. Thanks also to Cathrine Mavriplis, Charlene Sorenson, and Rachelle Heller for starting the wonderful Forward to Professorship workshop in 2003 and giving me advice along the way. And finally to the American Association of University Women and M. Hildred Blewett for having the vision of women returning to science.

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Panelists From L. to R.: Mark Olsen, Emily Monosson, Heidi Jo Newberg, Anne Douglass

Parenthood, the Elephant in the Laboratory

P A N E L I S T S

Mark Olsen, NASA/GSFC and UMBC; Emily Monosson, Author;
Heidi Jo Newberg, RPI; Anne Douglass, NASA/GSFC

Panel Discussion: Parenthood, the Elephant in the Laboratory

Panelists: **Mark Olsen, Emily Monosson, Heidi Jo Newberg** Chair: **Anne Douglass**

Motherhood, the Elephant in the Laboratory: Women Scientists Speak Out is a collection of essays by women scientists, most of who have raised or are raising families while pursuing scientific careers. Dr. Emily Monosson, a toxicologist and editor of the book, was inspired to pursue the project by the response generated by a few email inquiries to a listserv. The book is organized by the decade in which the contributor obtained a PhD, and every subsequent decade, starting in the 1970s, is represented. Their experiences and solutions to the issue of work-life balance are individual and varied. Questions about the appropriate work-life balance remain, and interest in the subject prompted the panel Parenthood, the Elephant in the Laboratory at the 2009 Women in Astronomy meeting. The panel included Dr. Monosson; Dr. Anne Douglass, an atmospheric chemist at NASA Goddard, contributor to the book and chair of the panel; Dr. Heidi Newberg, an astronomer at Rensselaer Polytechnic Institute and also a contributor; and Dr. Mark Olsen, atmospheric dynamicist at NASA Goddard. Each panelist spoke of their particular circumstances and an issue related to the unique challenges of raising children while pursuing a demanding scientific career.

Dr. Monosson, mother of two teenaged boys, spoke of the rewards of part time employment along with the challenges of grants as an independent researcher.

Dr. Newberg, mother of four, ranging in age from preschool to high school, noted that although she had followed what appeared to be a traditional path from graduate school to postdoctoral appointment to tenured faculty position, each transition was separate rather than as part of a single goal. Dr. Olsen, father of two young sons, spoke of his role on the board of the NASA Goddard Child Development Center and the importance of flexibility in his job for dealing with the unexpected since his wife's position as a dental hygienist is filled with inflexible appointments. Dr. Douglass, mother of five grown children, emphasized the importance of flexibility in both the home and workplace, and the need for a supportive environment beyond the first step of quality childcare as children grow and family needs evolve.

A question and answer session followed of which the subjects were varied and far-ranging. Some sought practical answers to everyday problems—how to arrange child-care for the summer for older children, with their many-sided interests and different needs from the pre-schools set, or how to adapt to the holidays, teacher work days, half-days, snow days and illnesses that add chaos to a grade-schooler's schedule. Panelists offered advice stemming from practical experience with summer day camps, high-school baby sitters employed on retainer for the half-days and holidays, or the advantages of hiring an au pair or a nanny (whether a high-schooler or a professional nanny, they must be paid well). Audience participants and panelists traded stories of the pleasures and pitfalls of bringing children along to a meeting or to class. When offering the example of their own experience, the common advice is that solutions are as individual as families, and parents need to figure out a balance within their own system.

A few spoke of administrative efforts to level the playing field, speaking specifically of allowing mothers some flexibility on the tenure clock and guidelines for both maternity and paternity leave. The ensuing discussion showed that fairness is difficult to achieve, as examples were cited where paternity leave afforded a new father relief from teaching but the free time was used to advance research rather than bond with his children. An institution may set a policy of maternity and paternity leave, but then they must take care to be sure that their policies are effective.

Dr. Douglass and audience participants with grown children agree on a few central points. A student or young scientist with children has no time to waste, and their focus on the task at hand can make a parent and scientist more productive than a peer with less responsibility. Parents and children together survive childcare and thrive. The passion for science can exist alongside a passion for one's children, and the conversation about the best way to feed both passions is likely to continue for a few more generations.

N.B. To see continued discussion on this subject please visit:
<http://sciencemoms.wordpress.com/>

The chair and panel members would like to express their gratitude to Lucy McFadden for taking the notes that made this paper possible.



EARNESTINE BAKER

Executive Director Myerhoff Scholarship Program, UMBC

The Meyerhoff Scholars Program

Earnestine Baker, Assistant to the VP of Institutional Advancement/Executive Director Meyerhoff Scholarship Program University of Maryland Baltimore County (UMBC)

ORIGIN AND HISTORY

Robert and Jane Meyerhoff and President of UMBC, Dr. Freeman Hrabowski, established the Meyerhoff Scholars Program at the University of Maryland, Baltimore County (UMBC) in 1988. The Meyerhoffs envisioned a scholarship program that would advance underrepresented African-American males in the Science, Technology, Engineering, and Math (STEM) fields.

Born in 1924, the Meyerhoffs matured during the Great Depression and World War II as members of a generation that believed in giving back to community and country. Their dedicated philanthropy has created a national legacy that spans the arts and sciences. After serving in the war, Robert Meyerhoff, a civil engineer and graduate of the MIT returned home to join the family construction business. He later left to establish Hendersen-Webb, a construction and property management company known for creating communities focused on quality and value. During this period, he and Mrs. Meyerhoff, a graduate of Goucher College, began to build the couple's outstanding collection of post-World War II art, which they plan to donate "to the nation" as a gift to the National Gallery of Art.

While the Meyerhoffs' contributions to education are many, perhaps the most significant is the Meyerhoff Scholars Program at UMBC. What began as an initiative to address the under-representation of African American men in the fields of science and engineering has evolved into a diverse program that now includes men and women from a range of backgrounds who share the goal of advancing minorities in the STEM fields. The program has received national acclaim for producing an outstanding number of high-achieving minority students in science and engineering and inspiring them to attain advanced degrees at the nation's most prestigious graduate and professional schools. A generation of talented graduates is now rising through the ranks of academe and the professions – a cadre of young leaders committed to tapping the talents of all individuals to advance knowledge and discovery. The Meyerhoffs have continued to support the program over the time with scholarship endowment funds, The Robert and Jane Meyerhoff Chair in Biochemistry, and the Robert and Jane Meyerhoff Science Fund, which supports teaching and research in the life sciences. In addition, the couple's deep personal interest and pride in the Meyerhoff Scholars themselves has added a nurturing element that strengthens the experience.

The Meyerhoff Program was created at UMBC in 1988 with a substantial grant from the Robert and Jane Meyerhoff Foundation. The Meyerhoffs provided an initial \$500,000 gift for the program to address the lack of African Americans, particularly male African Americans, in the science, math, and engineering pipeline. After the completion of the Bachelor of Sciences degree, the students will then pursue Ph.D.s and MD/Ph.D.s in these areas. In 1990, the Meyerhoff Scholars program admitted its first class of women and the program now welcomes students of all backgrounds who have a commitment to the advancement of underrepresented minorities in the sciences, mathematics, computer science, and engineering.

PROGRAM MISSION

1. To provide the necessary academic advising, social and moral support, encouragement, and enrichment experiences that enable a diverse group of undergraduate students to succeed in STEM fields.
2. Prepare students for terminal degrees in the STEM fields.
3. Prepare students to address and combat the underrepresentation in the STEM fields.

PROGRAM PHILOSOPHY: “IT TAKES AN ENTIRE UNIVERSITY TO EDUCATE A STUDENT”

1. The entire university should be involved administratively, academically and socially
2. Comprehensive Bridge Program
3. Program advisor the first two years
4. Retake STEM courses with “C” grades
5. Learn to study individually/groups
6. Activities with mentors and parents
7. Regular meetings to discuss class success

BARRIERS TO SUCCESS

Over the years the program has discovered several barriers that may impact success.

Important barriers identified:

1. The fear of disapproval or rejection by peers
2. Perceived hostile/non-supportive environment

3. Inadequate preparation to attitudinal/behavioral demands of the Academy
4. Specific gaps in knowledge/skill development
5. Limited exposure to models of academic excellence and scholarly practice
6. Overall low expectations
7. Isolation
8. Financial Aid

MEYERHOFF SCHOLARS SELECTION PROCESS

Nominees must have:

- A “B” average in college preparatory mathematics and science courses
- Outstanding SAT scores (at least, 600 Math score)
- Strong interest in pursuing doctoral and professional degrees in science, engineering or computer science
- Community Service/Community Involvement
- Interested in the advancement of minorities in the sciences and related fields

Nominations are received from:

- Private, public and parochial schools
- Superintendents, principals, and guidance department chairpersons

** Nominees may apply on-line or may request an application through the mail*

** Selected nominees are invited to an on-campus interview including Mathematics and English testing*

SUMMER BRIDGE PROGRAM OVERVIEW

The Meyerhoff Scholars Program expects all first year Meyerhoff scholars to participate in the Summer Bridge Program. The purpose of the six-week residential program is to develop a community of highly disciplined and committed scholars who are dedicated to the achievement of excellence in their undergraduate studies. Other goals include building group camaraderie, helping students solidify career goals, and acclimate students to the demands and expectations of higher education. The Program believes it is important for the participants to have a complete understanding of the nature of higher education. This understanding includes, but is not limited to, what it means to be an undergraduate majoring in a science or technical field and how college differs greatly from the high school experience.

Components of the Summer Bridge Program:

- Introduction to university academics
- Visits to technical and scientific sites to learn their chosen professions—researcher, engineer
- Courses Include: Calculus and Africana Studies
- Workshops Include: Physics, Chemistry, Mathematics, Study Skills, Public Speaking, Group Study, and Analytic Problem Solving
- Social and Cultural Events

STUDY GROUPS

Studying in groups is strongly and consistently encouraged and is viewed as an important part of succeeding in a science, mathematics, or engineering major.

PERSONAL ADVISING, COUNSELING AND TUTORING

A full-time academic advisor and other program staff regularly monitor and advise students regarding academic planning and performance and any personal problems that need attention. All Meyerhoff Scholars are encouraged to take advantage of departmental and University tutoring resources.

SUMMER RESEARCH INTERNSHIPS

Meyerhoff staff use an extensive network of contacts with companies, federal agencies, and other research universities to arrange summer science and engineering internships and create mentoring relationships.

MENTORING

Meyerhoff Scholars are paired with a mentor recruited from among Baltimore and Washington area professionals in science, engineering, and health. In addition, scholars have faculty mentors in research labs on and off campus, across the nation, and in other countries.

FACULTY INVOLVEMENT

Deans, department chairs, and faculty are involved in all aspects of the program, including recruitment, teaching, mentoring, and special events and activities.

ADMINISTRATIVE INVOLVEMENT AND PUBLIC SUPPORT

The Meyerhoff Program is supported at all levels of the University. Examples of external funding partners to date include NASA, NSF, NIH, IBM, AT&T, the Sloan, Lilly and Abell Foundations and Meyerhoff alumni.

FAMILY INVOLVEMENT

Parents are kept informed of their students progress and are invited to special counseling sessions if problems emerge.

ACCOMPLISHMENTS

Before the Meyerhoff program, UMBC graduated fewer than 18 African American science and engineering majors per year. Typically fewer than five of these students graduated with a grade point average of 3.0, a number consistent with other universities at that time. Since the establishment of the Meyerhoff Scholars program, Meyerhoff students were twice as likely to earn a STEM BS/BA degree, 5.3 times more likely to enroll in post-college graduate study, twice as likely to earn STEM BS degrees as Asian, Caucasian, and non-Meyerhoff African American students with similar preparation and interests. Meyerhoff students GPAs in science, math and engineering are higher than students with similar profiles. To date, the program has supported 768 students, 260 of whom are currently undergraduates with 86% (435 of 508) of Meyerhoff graduates earning science or engineering bachelor's degrees and 87% (379 of 508) going on to graduate and professional schools. In the near future the program will have an increase to 90% of students going into higher education.

The program conducted a comparison study with all students admitted to UMBC and to the Meyerhoff program but did not accept the Meyerhoff offer. The study found that 96% of the Meyerhoff students were retained in the sciences while 49% who attended other institutions were retained in science. It was clear that the Meyerhoff program's

environment, resources, and support services contributed greatly to the retention of the scholars. The retention rate in the Meyerhoff program is also 96%, and 86% of its graduates earn a science or engineering bachelor's degree and 87% go on to graduate school.

Since 1993, 22 scholars have completed the MD/PhD and 51 are currently enrolled. One-hundred-and-eighty-eight are enrolled in PhD programs throughout the United States and 63 scholars have completed their PhDs.

Since 1992, 70 Meyerhoff Scholars have been published including three on the covers of the *Journal of Molecular Biology*.

THE IMPACT ON UMBC

The average GPA of all African American STEM students at UMBC has increased from 2.70 in 1989 to 3.21 in 2005 (due primarily to the high achievement of the Meyerhoff Scholars) the average graduating GPA=3.42. The average GPA of white STEM graduates has remained relatively unchanged (3.17). There has also been an increase in STEM participation among UMBC minority students in general. The number of African American undergraduates majoring in STEM areas has increased seven times since 1985. Overall science/engineering enrollment among Latino students has also grown, as has the number of whites majoring in science/engineering during these same years. The number of Caucasian science and engineering major also increased during this time period.

THE LESSON LEARNED

Students affiliated with learning communities are more likely to be successful. A bridge program is important—or any program that can bridge a gap. Programs should be an integral part of the fabric of the university, not just one department. All components of the program should lend themselves to the broader mission and the purpose of the university. Finally, parental involvement is key to the success of the student and thus the program.

CONCLUSION

Just as the achievements of the Meyerhoff Scholars are the fruits of persistence, talent, and hard work, a success story like the Meyerhoff Scholars Program cannot exist without dedicated leadership and significant investment—from the president of a university and its faculty and staff to philanthropists, foundations, corporations, and public and private agencies. The experience of Dr. Freeman Hrabowski and his UMBC colleagues and students indicate that the results are clearly worth the effort.



CHRIS SCOLESE

NASA Associate Administrator

Remarks

Chris Scolese, NASA Associate Administrator

You are probably wondering why I am here, because I'm not a woman and I'm not an astronomer. In fact I'm an electrical engineer. But I did build a telescope when I was in high school and I did look at the stars. However, I could not bring that telescope with me anywhere. It must have weighed about two thousand pounds, because I ground my own eight-inch mirror and I couldn't get a tube so I had to build a box around it—and boxes work just fine, as long as they are dark. It ended up being too big. It took two of us: a friend helped me pull it out at night to look at the sky. So I did look at the stars, and it was something that was really interesting.

I should mention that one of the tasks that I had as the Deputy Director of the Goddard Space Flight Center was to head the Diversity Council for the center. That job was to try to make sure that Goddard was a place that welcomed all people, regardless of race, creed, gender, or sexual orientation. It was an interesting job that I really enjoyed, and in many ways I miss it because I don't get to go out and meet with these people as much as I did before.

However, as the Associate Administrator I still have an opportunity to meet interesting folks. One of the pleasures of my present job is meet the people at the centers and the various institutions and help them bring in the next generation of scientists, engineers, and technicians that are going to make our future missions possible.

I recently read a book called *The Difference*, by Scott Page on the importance of diversity. He makes a statement that is absolutely critical for all of us to think about: "We possess incredible capacity to think differently. These differences can provide a seed of innovation, progress, and understanding." When we all act alike, look alike and we all think alike, we hinder our chances of achieving things that have never been achieved before. It is not feasible to have this kind of unilateral thinking in a profession where you are trying to discover things that don't always make sense. We need to have a variety of people who can think differently in order to make things work and produce the best science possible.



In the 1950s you notice that the Mercury astronauts were all men, while today virtually all missions that fly have a woman astronaut. We have had two women commanders fly multiple times on flights, so we have come a long way. What is not shown here are the women astronauts who were picked for the Mercury program and were never given the opportunity to fly.



NASA Yesterday and Today		
Year	Women in NASA workforce	% of total NASA workforce
1969	5,541	17.5%
1988	6,015	27.4%
2009	6,160	32.8%

In 1969 most of the women were not in the science and engineering divisions at NASA. Of course, we were a bigger agency then, so if all the numbers don't seem big the percentages have increased considerably since that time. I came to NASA in 1987. Before that, I was probably among some of the first men to be in an engineering school where there were a significant number of women in the classes. When I came into the military it had already been about five years since women were allowed into semi-combatant positions. The reason I say semi-combatant is because I managed to serve in the military when there was no combatant role to be had. I came into a very different workforce than most of my male comrades did at the time, and you could see the difference. Today I can tell you, and you all know looking around this audience, it's an entirely different world that we live in.



Diversity has to go even farther. To the left is an image of the Braille coin that NASA's STS-125 mission flew aboard during a Hubble Servicing Mission. NASA is one of the few agencies that really has embraced diversity. As an example, we hold a very strong partnership with the American Federation for the Blind, and have partnered with them in a number of programs. These

include helping them advertise the Braille coin and participating in its dedication ceremony on Capitol Hill. This is just a small example of the institutions that we visit and with whom we work. We also work with schools, beginning at the lowest grade levels and up to the college years. We've sent our scientists and engineers to go and work with the American Federation for the Blind so we can get science and engineering out there. Dr. Anne Kinney was very much involved with the first Braille book of the universe that was published to give those with impaired vision a view of Hubble. The book, and it is something to marvel at, opened up the universe to the blind. There is also a book that explains planetary images. It is really wonderful to see the inspiration it gives. When I was there, there were about 400 students with various sight impairments that were virtually undetectable. They knew as much about science as you could imagine. They could tell you what a nebula looked like and they could tell you what the light of a nebula looked like. It was an amazing experience for me. They certainly are going to be great contributors to the workforce as they progress with their education and careers.

Now I would just like to make a few points by mentioning a few people that made an impact in my life. I have tried to put some accounts together about the things I saw as I was maturing. Caroline Herschel was somebody I read about when reading about William Herschel. It was early on when I realized that "Herschel would not have been Herschel without Herschel." I thought that since I am here at this meeting, I should mention this fact: one of the earliest known and published astronomers was a female.

A woman that had a great impact on my career was a pioneer whom I happened to meet when I was in the Navy: Admiral Grace Hopper. She showed me what a nanosecond looked like; she was one of the people that got the Navy on the right course with computers and computer software and probably the whole world. Hopper developed the first compiler for a computing programming language. She taught us that with discipline you can have success. She was a real inspiration to a lot of people.

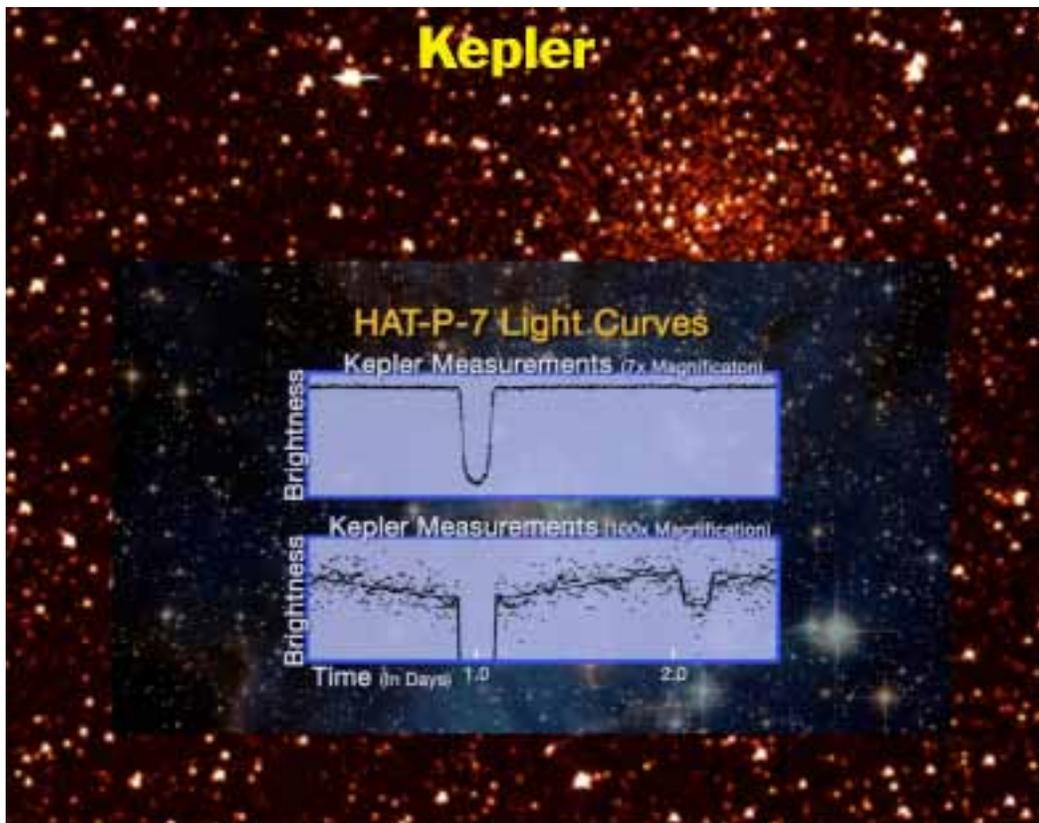
At that time I was working for someone named Admiral Rickover, who was equally demanding. Someone who invented the nuclear submarine and became known as the

“Father of the Nuclear Navy” had every right to be demanding. It was rather an interesting environment to work in, but they were both people to be respected. They knew what needed to be done, they knew the discipline that one had to have, and they led by example.

Of course Rachel Carson was somebody I think everybody that grew up in the '60s and '70s read as we became aware of our environment in a deeper and more important way. When I came to Goddard, I had an opportunity to work in either astrophysics or earth science and, of course, I chose earth science, and it was probably because I read *Silent Spring*. It might also have been because I watched the Buffalo River burn, which is where I grew up, and if you've never seen a river burn you haven't seen anything. It's a sight that should really be avoided at almost any opportunity. But my father did take me down to see it and I watched the firemen sit there and try to figure out what in the world to do.

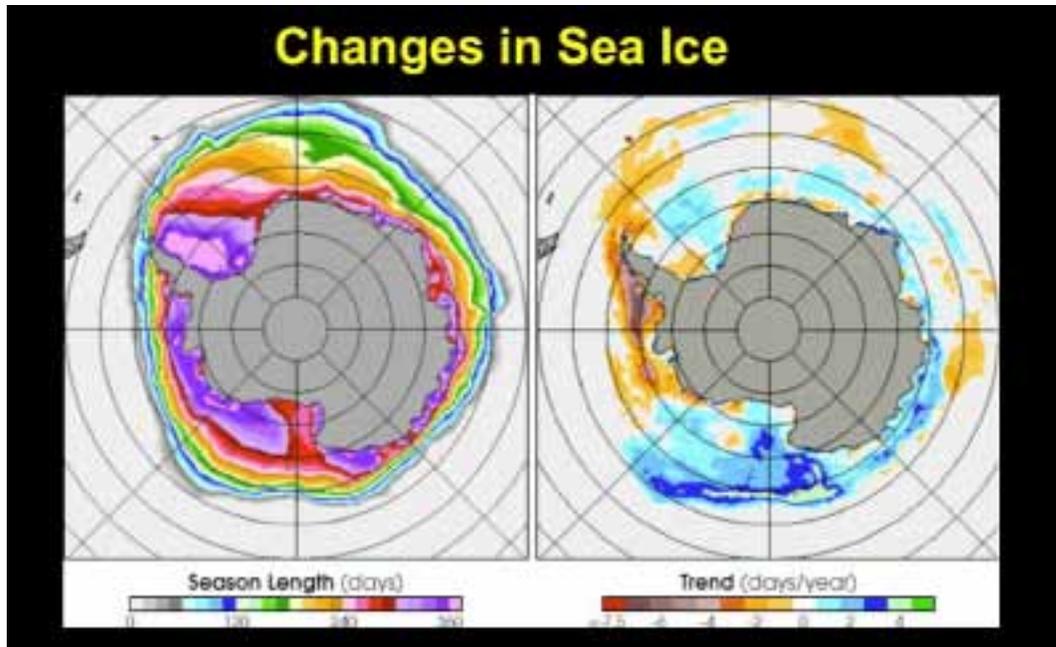
You may ask, “Why put those two together?” Because we need computing power in order to have the missions we have today and continue to explore all sciences. This is very true for earth science. For example, when I first started doing the Earth Observation Satellite (EOS) missions, the idea that we could bring down a terabit of data was considered impossible—not a terabyte but a terabit. No one could believe that we would be able to ingest that amount of data and this was not that long ago—it was the 1990s. Of course, today you can ingest a terabit on your PC at home or you can watch a movie that you download from whatever service that you might use. We needed to keep these technologies developing.

So here's an example of some of the earth science missions. Here is the future that we're looking at, and there are many more missions, but these are the ones that are coming up. So even here, why do earth science? Well, some of the better scientists I have met were astronomers; they were just the astronomers who didn't like to stay up at night. But they developed some of the finest instruments that we have actually flown on a spacecraft. So as astronomers there is an incredible array of things that we can do.



We also have some fantastic missions out there that are opening the universe in several different ways. Kepler is of course in orbit, searching for extra-solar planets. It has not discovered anything new yet, but it's certainly demonstrating that it will and, at some point, hopefully find some terrestrial planets. The above photograph shows some of the measurements of Kepler, and as you can see we've seen some of the brightness changes that indicate that there are planets. So Kepler is working. It's beginning to enter its science phase, and over the next few years hopefully we'll see those dips happening over a year as opposed to having them happen over a few days where they aren't going to do very much good for light curves—they're too close to the sun to be able to make those workable.

Of course, there is also the James Webb Space Telescope that has some incredible capabilities to allow us the possibilities to see deep into the universe. Those of you in the audience can tell me more about these than I can, but this gives you an idea of the capabilities that exist.



Finally, this photo (above) shows the changes in sea ice. It comes from Claire Parkinson, a good friend and colleague at Goddard. Claire has done some seminal research in ice and what is actually happening with it. This is a product of something that she developed that clearly shows that Arctic ice has been shrinking. It was one of the discoveries and demonstrations that made it clear to people to stop denying that global climate change is actually occurring. You can't ignore the fact that one day there might be a clear sailing passage from East to West. The science data that Claire was researching has clearly demonstrated this. This is yet another case where a woman has made a huge difference in our understanding of Earth.

I am reminded of the words of Dorritt Hoffleit: "When it comes to astronomy you never reach the end of anything, you have to reach out farther and farther into the universe." These are the women who made a difference and you are the future generation that will succeed in their steps.

Thank you.



PEGGY MCINTOSH

Associate Director of the Wellesley Centers for Women
Founder and Co-director, National SEED Project on Inclusive Curriculum
(Seeking Educational Equity and Diversity)

Unearned Advantage and Disadvantage as Work Impediments

Peggy McIntosh, Associate Director of the Wellesley Centers for Women,
 Founder and Co-director, National SEED Project on Inclusive Curriculum
 (Seeking Educational Equity and Diversity)

I have had several wonderful experiences recently at NASA/Goddard owing to the kind invitation of Pam Millar to present at Women’s Equality Day and then to return for this conference. I appreciate all the events and the vibrant participants. On my first visit, my mental world was transformed by sitting in Laurie Leshin’s office and having her put into my hands a slice of a meteorite over four billion years old. And then hearing her say that the dark spots in the meteorites were composed of carbon and amino acids. Carbon and amino acids! How astonishing! Astonishing! Why? Because I had been very ignorant about the contents of the universe. I knew the name Cecilia Payne-Gaposchkin, but I didn’t know that she had found that hydrogen was the basis of the entire universe, and I didn’t dream that there were carbon and amino acids in outer space. The co-director of my project with K-12 is a Cherokee woman, a Tslagi woman, from North Carolina. I knew that people of her culture say that their ancestors came from outer space; that life had come from outer space. She was told they came from the Pleiades. Laurie told me that it wouldn’t be the Pleiades. I haven’t passed on that information. But I will pass on this electrifying information about a four billion year old meteorite carrying amino acids and carbon. What a unifier for me! What a flash of new understanding—so “space” is not “alien” to us on earth.

I am here because I wrote a paper called *White Privilege: Unpacking the Invisible Knapsack*. A few years ago, Sheryl Bruff asked me to come and speak about my work at the Space Telescope Science Institute, and I did. And Pam Millar, despite of all the rest that she does and has to do, nevertheless went through the video archive of the talks given for Sheryl’s wonderful STScI series called “Hard Science, Soft Skills” and found this talk I had given and invited me to come to NASA/Goddard eight or ten weeks ago, and then here.

These visits are a thrill for me for several reasons. One is that I am a really good friend of Lyman Spitzer’s daughter and she and I just yell and cheer for the Hubble Space telescope in a way that we never would for a sports team. We’re in love with the Hubble Telescope. In addition, my father was with Bell Telephone Labs when they sent up Telstar, and I still remember that. My father was fairly agnostic, but one day he brought home a quartz crystal and said to us in a hushed tone, “This thing has miraculous properties.” It was an artificial silicone crystal. He had just learned how much information you could put on a sliver of silicone. And he put that crystal under a bell jar. I couldn’t

imagine what it was all about, to elicit this response from my father. But all of his subsequent work and of course all the work that NASA does, would be impossible without that technology—this miraculous silicone chip and all that has followed from its use.

Another thing that is significant for me about space and science in my upbringing is that my parents were so shocked when we dropped the bombs on Hiroshima and Nagasaki that my father asked to be taken off war work for the duration of his professional career at the Bell Labs. He had come to understand that the Nike missile systems that he was involved in designing, as an engineer, would be for the delivery of atomic warheads. And he felt atomic bombs must never again be used. And so my parents became pacifists and Quakers, and sent me to a Quaker school, hoping that the very inclusive theology of Quakerism, which is really very brief, would take on me. That theology can be summed up in one statement: “There is that of God in every person.” Not “There is God in every person,” but “There is that of God in every person.” And this Quaker education did take, in a way. I entered the school as a very stuck up little 15 year-old, identified with authority. I thought these Quakers were wasting our time talking about all kinds of different world religions and all kinds of people. I thought Quaker meetings were pretty stupid if just anybody could speak. I was looking for a minister, who would give us a sermon, but a Quaker meeting is a silent hour and anybody may speak.

Over the years, though, Quakerism took, and part of the reason I am here with you today is that the Quaker practice of respectful listening to everyone gave me the capacity, years later, to hear what my colleagues of color were saying. And I realize now that a whole lot of effective mentoring consists of listening, listening, listening, and then reflecting back, tentatively, what you think you’re hearing, so as to italicize speakers to themselves. I think that this is a sacred act—to italicize the souls of people, reflect them back to themselves, respectfully. It hasn’t been done for enough of the people on the face of the earth but it’s part of what led me to be able to reflect on my experience and to imagine that in whiteness there were problems that didn’t have to do with meaning well, but did have to do with being over-entitled and developing skewed values as a result.

If you go back to Abby Stewart’s talk yesterday on unconscious bias, you can see my talk as sharing that foundation, and also going in a somewhat different direction. In addition to unconscious bias against some people, institutions, and ideas there is unconscious bias in favor of some people, institutions, and ideas. This is over-entitlement, which is a major actor in the politics of people’s choices. It maldistributes opportunities for choice, material goods, power, and respect.

If you imagine a hypothetical line of justice, this is the way I see the difference between unconscious negative bias and unconscious positive bias. Here's the hypothetical line of justice, stretching out laterally, parallel to the ground. Below it, groups or individuals are pushed down and suppressed, wounded, enslaved, or discriminated against in myriad of ways. Below the hypothetical line of justice, negative treatment and negative projections occur. This is called bias; it's called discrimination; it's called exclusion; it's called destruction. But above the hypothetical line of justice is the universe of privilege that we have not been taught about—not in schools, not in universities. Never think that higher education taught you about this. It just didn't, unless you have taken recently some of the more modern courses on privilege that are just being developed now. But above the line of justice you are pushed up, through no virtue of your own, in ways that give you power that you did not earn, but come from positive projections onto you. The resulting advancement and comparative safety are likely to give you a sense of superiority and of rightness. This is the phenomenon I want to speak about and have you speak about on the basis of your own experience.

Because we are here, at a Women in Astronomy conference, in preparation I was thinking about white women, all people of color, gays and lesbians, and poor people. I began to develop a metaphor that maybe awareness of privilege is sort of a second stage rocket. So here's the big initial rocket of understanding about discrimination but here's a kind of second stage rocket, taking us further into understanding of unearned advantage as against unearned disadvantage. But to tell the truth I wavered about that second stage rocket metaphor because I didn't know what it was saying, what it was meaning, where it was going. I don't know that much about how you can improve on the first stage by setting off a second stage rocket. Do you get to see more? I believe so. I do feel it's necessary to see beyond negative bias to the positive bias of over-entitlement. Below the line of hypothetical justice there are important truths to be learned, but above it there are vast truths that haven't even been seen—the untracked effect of privilege in our lives, which has the most minute as well as the most far-reaching consequences. Everybody in this room has both unearned advantage and unearned disadvantage and both of those impede good relations with others and good work in our workplaces and our world. We need to increase awareness of these so that they do not interfere so much with our capacity to live full and responsive lives and make good workplaces.

Soon you will have a chance to compare, one-on-one, for one minute each, some of your own experience of unearned advantage and disadvantage. But first I'll tell you how I came to see that I have white skin privilege and I'm going to spell it out in some detail because you have those analytical minds that allow you to follow, and I hope take an

interest in, this trajectory. Three years in a row, men and women got into an impasse at a seminar I was leading at the Wellesley Centers for Women. The subject of these seminars was how to bring materials on women into the liberal arts curriculum in all the disciplines, including what are now called STEM fields. And I thought I must have done something wrong because the men in these seminars were such nice men. They were our allies; they were our friends. And yet we got to a point each spring where we didn't trust each other any more. We would start the seminar in September and go until about March, in these collegial monthly seminars with nice big dinners. And then each spring there would be this sense of a falling out between the men and the women, all of them professors. The morale would break down, emotionally, between the sexes, and by June you could feel a palpable relief that the seminar was ending. This happened three years in a row with a different group of college teachers each time—a total of 22 college teachers each year who came from all over New England, New York, New Jersey and Connecticut.

I didn't want to stop facilitating the seminar series. It was very popular. It was over-enrolled. I valued the work we were doing, but I thought that I could not get re-funded unless I confessed to the donor, the Andrew W. Mellon Foundation, that I had goofed up as a facilitator and that if they gave me another \$325,000 I would mend my ways. So I went through my notes trying to see what I had done wrong as a facilitator. The assumption that I had done something wrong and caused the friction is part of what I now think of as a pathology in white upper middle-class or upper-class women. When something we are directing doesn't go well, we tend to take this as a mark of our personal failure, rather than imagining that a big system may have conduced the failure. So I went back through my notes, looking to see what failings I should confess to. What I found was that I hadn't done anything wrong, but the women had raised an incendiary question in the spring of each year, once we felt comfortable with the men. The question took slightly different forms each year, but the basic query was, "How can we get these new materials on women into the first year courses, the freshmen courses?" And the men, to a person, three years running, according to my notes, resisted this organically developed idea. The women were feeling, as Congresswoman Edwards has just told us, "that we need to get these insights in earlier." In other words, the women felt that we can't wait until students are in a senior seminar, or reading some feminist critiques in graduate school. The women in our groups wanted these materials on women in the disciplines to come in at the beginning of the college years.

The men said, "We're sorry. This is fascinating, this new research on women, and we are really enjoying this seminar, but we can't put in anything on women in the first year. The syllabus is full. The course is full." And one man said—I wrote it all down—

“When you’re trying to lay the foundation blocks for knowledge you can’t put in soft stuff.” Thanks a lot! It’s such a vaginal comment; it makes me annoyed now as it did then. It is the “Men are from Mars, Women are from Venus” nonsense. We were surrounded by piles of serious scholarship on women that was not soft. And whose mother is really soft? But the thing is that the man who said it was a very nice man. Another man, another year said, “The students in the first year are trying to choose their major. That’s their discipline. If you’re trying to get them to think in a disciplined way, you can’t put in extras.” So every one of these men is born of a woman, and she has become extra, together with his sisters and aunts, maybe his partner and his daughters, and especially his grandmother. But he too was an extremely nice man. These men were also very brave to take the flak on their own campuses for going to a feminist seminar at a women’s college, and spending all this time working with feminists. Other men looked askance at them.

So I found that although the men made comments I found oppressive, the men didn’t seem individually oppressive. Their comments were oppressive. I went back and forth in my mind: “Are these nice men or are they oppressive men?” And I thought I had to choose; EITHER they are oppressive OR they are nice. Then I was rescued by remembering two essays written by black women in the Boston area six years before. I remembered that I had been stunned in 1980 to read essays by women of color in the Boston area—African-American women who had spelled it out as though it was the Lord’s own truth that white women are oppressive to work with. I remembered being astonished that they felt this way. We? Oppressive? I remembered what my shocked responses had been six years back. My first injured feeling was, “I don’t see how they can say that about us, I think we’re nice.” It’s silly, isn’t it? I thought white women were nice, generically, maybe even genetically nice! But the second response is much more embarrassing. It’s outright racist, but this is where I was in 1980. I remember thinking; “I especially think we’re nice if we work with them.” You can hear the white supremacy in that. I realized I had expected thanks from women of color. I had expected thanks for working with people I had been taught to look down on. That wasn’t so nice was it? Then I went back and rethought the whole thing. For a couple of years I was in a real panic. Did these attitudes show? Did my colleagues of color know how racist I was? Of course they did. But I first hoped I had successfully disguised under “niceness” my deeply condescending racial attitudes.

Finally I asked myself, was I really oppressive to work with? And after those years of dithering I told myself, “Yes. They worked with me despite my oppressiveness.” For at the time, women of color could see I was at least trying. I had even been teaching about some black women’s literature, but only seeing below the hypothetical line of justice. I was teaching “how terrible for them”—this set of stories they had to tell. Not seeing,

“how exempt for me, to be so free”—to be free of the experience of having children go to school with teachers who assumed they couldn’t read or write; the experience of being looked at with hostility when you were standing in line at a bank teller’s window. This is hard to describe to today’s audience because so many people don’t know how we used to get money from a bank—by standing in line, in a building. Black women talked about being looked at as though they were about to hold up the bank. Black women wrote about what it was like being in a supermarket and having the checkout clerks assume they were using food stamps. This is all below the hypothetical line of justice.

Up until then, 1986, I had had no clue that my basic attitudes had been formed above a hypothetical line of justice. I didn’t see myself as oppressive. I didn’t see there was any negative effect on others of growing up as I had. But once I had figured out that, yes, I was oppressive to work with, then I decided this: I think niceness has nothing to do with it. You can be as nice as can be and still have a basic attitude of superiority that was trained into you. And I saw that these men were nice; indeed they were nice, they were brave, they were our friends, and at the same time they were very good students of what they had been taught, which was: men have knowledge; men make more knowledge; men profess knowledge; men publish knowledge; men run the major research universities. Men had picked up the messages that knowledge is male and men are knowers. And it was not their fault. I see it not as a matter for blame, shame, and guilt. It’s simply a matter of their learning in the systems they were born into.

This is where your scientific minds will help you to think through all of this, and work on privilege without falling apart emotionally. As scientists, you can understand factually that men have absorbed the message that knowledge is male and men are knowers. Once I got through to that point of reasoning, I thought, “No wonder my husband can’t ask for directions.” To this day it goes against his identity to hop out of a car and say, “We’re lost. Can you tell us where to go?” But I was taught in the 1930s and 40s to lean on men or lean on authorities who can give you information. So I am quite willing to get out of a car and say, “I’m lost, can you help me?”

Then I realized, “Niceness has nothing to do with it in my case either.” I was the wrong sex for entry into the knowledge system until the government came to Harvard in the 1960’s and said there are only men in the English department, so you must hire a woman. That’s how I got to teach at Harvard. But I realized that when Harvard was forced to change, it was white women, two of us that the men admitted to the staff. For though we were the wrong sex we were the right color. I realized then that I had been taught, and now the litany starts again: whites have knowledge; whites make more knowledge; whites publish knowledge; whites profess knowledge; whites run all the

major research universities; whites run the university presses. Widener library is full of books about people from all over the world written by whites. And I realized I had been taught that knowledge is white and whites are knowers. So no wonder we were seen as oppressive to work with.

And to this day I second-guess, in my mind, my colleagues of color in my major project. There are fourteen teaching staff every summer; nine are people of color, five of us are white. To this day, mentally I second-guess what my colleagues of color say unless I have installed in my awareness or my heart what I now think of as Alternative Software. My hard drive will doubt my colleagues of color every time, will test everything that they say relative to my “superior” white knowledge, but the Alternative Software is transformational. It is the piece of software that allows me to know how much I have learned from my colleagues of color, how much the excellence of our project is dependent on them, how much they have to teach everybody of any ethnicity who comes into our main workshop in California in the summer. They are at the heart of the excellence of the project.

To have a project or workplace that works well for everyone it is necessary to lessen the hold of privilege on our assumptions and customary behaviors. I like to imagine that at NASA, people of color can be at the heart of its excellence. Its got excellence already, it can have more excellence; people of color know so much more than we do about almost everything, although not necessarily the STEM subjects within which, if whites were seen as the prime knowers, they were given the expectation of success much more than people of color were.

Well, having seen those two parallel systems of race and gender privilege in the knowledge system, creating parallel assumptions about who is a “knower,” I thought: “No wonder I can get grants and my colleagues of color at Wellesley can’t. I’ve got the whole knowledge system on my side, and because foundations run by whites give grants, I have the money system on my side. So no wonder my colleagues of color can’t get grants and I can. It hasn’t to do with excellence. It has to do with privilege, with connections to the worlds of money and of knowledge.”

And I asked myself what else do I have that I didn’t earn? And my conscious mind with the three degrees from Harvard said, “Nothing.” So I asked again, “On a daily basis, what else do I have that I didn’t earn, by contrast with my seven or eight African-American colleagues in this building?” and once again my conscious mind said, “Nothing.” A total block! That’s why I said not too long ago at the Kennedy School of Government: “Never think you’re getting a good education here on power. You are not being taught about how power travels. You’re not taught about privileging systems in you and around you. Never think you’re learning about power here. You’re learning about management. And, of course, take the credential and run with it. But never trust that you’ve got a good training in the taboo subjects of over-entitlement and unearned power.”

So I didn't trust that Harvard-trained mind that answered "Nothing." And I remembered also that when I wanted to write my dissertation on Emily Dickinson, I was told by the chair of the Harvard English department: "You can't write about her because nobody knows her." Nowadays, that sounds ridiculous, doesn't it? But I think what he meant is, "We don't know her, and if we don't know her then she really doesn't exist." And that was a very characteristic Harvard English department attitude of about 1963. I decided that I would have to go deeper into this matter of privilege even though it was "unknown." I remembered a passage of Virginia Woolf. When she was sitting at her writing desk on the south coast of England, she was astonished to see that out of the water of the marshes came a huge fin that arced and went back into the water of the marsh. She wrote of this fin in her diary; "I could not see what it was attached to, but I knew it was attached to something very big."

I thought I had seen a fin. My conscious mind was refusing to answer my urgent question I had about other kinds of privilege, so I decided to pray over it. This was not the usual kind of prayer, it was a demand. Like Gerard Manley Hopkins in spiritual crisis, writing "The Terrible Sonnets." And I made this demand: "If I have anything that I didn't earn besides the money system and the knowledge system working for me, and not for my black colleagues, show me!" And I went to bed that night, and in the middle of the night, up swims an example. I switched on the light and I wrote it down. It's comic to me that I'm an English teacher, and all of my examples came in fully formed sentences. I remember writing it down that first one and in the morning looking at it and thinking; "This isn't very much of anything." It became the first of 46 examples in my list of unearned advantages I have as a white person by contrast with my African-American friends in the same building. This sample was tiny, place-wise, race-wise, gender-wise, region-wise and even vocation-wise as we all worked at a Center for Research on Women. But I knew the stories of some of these colleagues, and as I say, I had been imagining "how terrible for you," but not, "how exempt for me." And suddenly my subconscious, which knew it all along, knew it perfectly well, dished up example after example after example for three months. The examples are very specific and came out of my own daily experience and knowledge.

I will now distribute the abridged list of examples. That first one that made me think, "Well that's not much of anything," turns out now to be significant. At the time, I was just doing what the subconscious told me to do, which is to write these things down. The example was: "I can, if I wish, arrange to be in the company of people of my race most of the time." I thought it was unremarkable but at least it was something. Now I see it has a lot to do with the phenomenon of being, say, one of three women in a sea of a hundred men in a workplace. The privilege is in not having to be lonely, racially, each day. Or not having to feel like the "only."

At this point the session became interactive. McIntosh distributed copies of “White Privilege: Unpacking the Invisible Knapsack” from *Peace and Freedom Magazine* (July/August 1989). She asked, “how many of you have read this paper before? I’d like to collect three examples.” After some discussion of the examples volunteered by members of the audience, McIntosh read a number of her examples from the list that appears in the paper.

Eighteen of her original 46 examples are listed here:

- I can, if I wish, arrange to be in the company of people of my race most of the time.
- When I am told about our national heritage or about civilization, I am shown that people of my color made it what it is.
- I can be sure that my children will be given curricular materials that testify to the existence of their race.
- If I want to, I can be pretty sure of finding a publisher for this piece on white privilege.
- I can be fairly sure of having my voice heard in a group in which I am the only member of my race.
- I can go into a bookshop and count on finding the writing of my race represented, into a supermarket and find the staple foods that fit with my cultural traditions, into a hairdresser’s shop and find someone who can deal with my hair.
- I did not have to educate our children to be aware of systemic racism for their own daily physical protection.
- I can swear, or dress in secondhand clothes, or not answer letters, without having people attribute these choices to the bad morals, the poverty, or the illiteracy of my race.
- I can remain oblivious to the language and customs of persons of color who constitute the world’s majority without feeling in my culture any penalty for such oblivion.
- If a traffic cop pulls me over or if the IRS audits my tax return, I can be sure I haven’t been singled out because of my race.
- I can go home from most meetings of organizations I belong to feeling somewhat tied in, rather than isolated, out of place, outnumbered, unheard, held at a distance, or feared.

- I can be pretty sure that an argument with a colleague of another race is more likely to jeopardize her changes for advancement than to jeopardize mine.
- I can choose to ignore developments in minority writing and minority activist programs, or disparage them, or learn from them, but in any case, I can find ways to be more or less protected from negative consequences of any of these choices.
- I can worry about racism without being seen as self-interested or self-seeking.
- If my day, week, or year is going badly, I need not ask of each negative episode or situation whether it has racial overtones.
- I can arrange my activities so that I will never have to experience feelings of rejection owing to my race.
- I can take a job with an affirmative action employer without having my co-workers on the job suspect that I got it because of my race.
- I can choose blemish cover or bandages in “flesh” color and have them more or less match my skin. (Copyright 2010 by Peggy McIntosh. May not be reproduced without permission of the author: mmcintosh@wellesley.edu.)

After reading such examples, McIntosh then facilitated an interactive exercise in which each audience member paired up with another person. Each was asked to tell their listening partner for one minute, uninterrupted, about ways in which she or he had had unearned disadvantage in life. Then they were asked to switch roles, with the first speaker now listening. The second part of the exercise involved each person talking for one minute, uninterrupted, about ways in which she or he had had unearned advantage in life.

McIntosh introduced the exercise by saying: “You’ve all had histories of arbitrary, circumstantial advantage and disadvantage with regard to class or race or gender or nation of origin or religion or first language or neighborhood, or your body type, or maybe your place in the birth order, and so on. These are all matters of arbitrary unearned advantage and disadvantage. None are causes for blame, shame or guilt. You did not invent the systems you were born into.”

After timing the testimonies at one minute per person per topic, McIntosh said of the use of such strict timing, “I call this the ‘autocratic administration of time in the service of democratic distribution of time.’ It is rare in work places to find time distributed democratically.”

McIntosh concluded by saying, “To return to problems of the workplace, I believe that all the systems of unearned advantage and disadvantage can interfere with good work. They tend to create in the workplace the same hierarchies that plague us in communities, in institutions, in the wider society, and in the inner workings of the psyche. And privileged distribution of time is just one of the systemic problems that can interfere with good group work. Having unearned privilege or disadvantage of any kind carries over into the ways people relate to one another in the workplace, and those who have most circumstantial power are likely to hold assumptions that keep power in their own hands, whether or not they are aware that this is happening.

People of my ethnicity are not likely to associate excellence with level-headedness, exactitude, intellectual modesty, curiosity, foresight, and attention to all kinds of detail. We are more likely to associate excellence with enterprise, initiative, daring, will, vision, and genius. People of my ethnicity often project onto ourselves big virtues and small virtues, without inquiring much about alternative constructions of excellence. Remember this in all hiring and in all promotion. It’s a legacy of white privilege and male privilege to think that excellence must look the way it always did and that definitions of leadership need not change. I feel that leaders in our time need to be keenly aware of what Adrienne Rich has named the “politics of location.” They need to be sensitive about how power and approval have been distributed unequally, and how the effective 21st century workplace needs everyone to be empowered and included.

Studying privilege has led me to see another way in which I am free of the stresses below the hypothetical line of equity. In order to do well in this society, I do not have to wish to be accepted racially or class-wise, or with regard to my sexual orientation. I can live my daily life without giving these matters a thought. The temptation is to see myself as normal in these respects, rather than privileged. Privilege allows those who have the most power to see themselves as the norm rather than as what we really are, bodies in the body of the world. We are all different bodies in the body of the world and of the universe. I was so happy, Rob Strain, when someone called you “the Master of the Universe,” and you didn’t accept the term. Thank you.

Both unearned advantage and unearned disadvantage lead to attitudes that are internalized and interfere with good work in the workplace. I have quite a few notes on this. However we got off to a late start but I have loved being in your midst and I am very glad you are working on all of these matters so wisely and seriously.

Thank you.”



What it Takes to Become a Principal Investigator,
Project Scientist or Instrument Scientist

P A N E L I S T S

L. To R.: John Mather, NASA/GSFC; Sally Heap, NASA/GSFC;
Julie McEnery, NASA/GSFC; Joanne Hill, NASA/GSFC; Jean Swank, NASA/GSFC

Panel Discussion: What it Takes to Become a Principal Investigator, Project Scientist or Instrument Scientist—*Diana Khachadourian*

Chair: **John Mather** Panelists: **Sally Heap, Joanne (Joe) Hill, Julie McEnery, and Jean Swank**

Dr. Mather is a Senior Astrophysicist in the Observational Cosmology Laboratory at NASA's Goddard Space Flight Center. He is also the senior Project Scientist for the James Webb Space telescope. His research centers on infrared astronomy and cosmology. He is the 2006 recipient of the Nobel Prize for Physics.

The panel discussion opened with Dr. Mather listing the key points that will be discussed during the session. Each panel member was asked to address events seen as pivotal in their careers. These included key educational events; mentors; key things they have had to learn; characteristics they feel are required of a leader; situations they feel are helpful to a leader; how to obtain the necessary support for projects; and major obstacles that turned up along their career paths.

Mather turned the discussion over to **Dr. Jean Swank** who is an astrophysicist at the Goddard Space Flight Center. She is the Principal Investigator for the Small Explorer mission Gravity and Extreme Magnetism Small Explorer (GEMS), which was selected to be developed for a launch in 2014.

Swank made a few key points. She emphasized that one of the requirements for people in these positions is experience. As an example she worked on three missions before she became the Project Scientist on the X-Ray Timing Explorer (XTE). But she said that, "The aim is to do something and not necessarily be a PI or a PS. In my opinion the aim is to help the project be successful."

Team-work is also of value in that there is usually too much work for one scientist to handle. And having diversified and broad interests will also aid in being able to work on a range of projects as a lead scientist or investigator. A good back-up and support group is essential. Dr. Swank explained that when she was to become a lead scientist there were "*rumbles*" as to whether she was strong enough for such a position. There were doubts as to whether she could defend the mission. But she succeeded because the director of science, leader of the x-ray astronomy group, and leader of the lab backed her up.

She has seen significant changes in her long career at Goddard. In her early years at GSFC she was the only woman in the meetings for launch readiness. Now it is closer to 50-50. She also remembers that the women who were lead engineers on the XTE who decided to have children would terminate their careers. This has now changed and Dr. Swank sees a number of women who have chosen to both have children and carry on with their careers.

Dr. Joanne (Joe) Hill is senior scientist at the Universities Space Research Association (USRA) working in the Astrophysics Science Directorate at the Goddard Space Flight Center. She is the Principal Investigator for the development of a wide field of view gamma-ray burst polarimeter and also serves as the polarimeter system scientist for the Gravity and Extreme Magnetism SMEX.

Although Joe Hill's mentors were and are all men, she said that they were a huge encouragement to her because, "They taught me everything I needed to do to move on and be a lead on a project."

As Jean Swank had mentioned earlier Joe also agreed that learning different things that is required in a mission is a strategic move. Being able to adapt quickly to different situations can save a project. Making sure that you can make a good science argument for your project is also valuable in achieving a lead position.

Lastly, Joe Hill said, "Never believe the first person who says, 'It can't be done.'" But heed the warning if it's five or six who say the same thing!

Dr. Julie McEnery is the Fermi Mission Project Scientist and an astrophysicist in the Astroparticle Physics Laboratory, Astrophysics Science Division of NASA's Goddard Space Flight Center in Greenbelt, Md. Since 2009, she is also an Adjunct Professor of Physics at the University of Maryland's College Park campus.

Because of the increasing diverse population of scientists in the US Julie McEnery made an excellent point mentioning that the biggest career obstacle was that she was at first not a U.S. citizen and did not have a Green Card. It was difficult to get involved with spacecraft related projects because of International Traffic in Arms Regulations (ITAR) concerns.

Other remarks made by McEnery were that it is important as a PI to work broadly with the press and public outreach. It is this kind of close contact that will get a project noticed. Julie emphasized that it is important to listen to those who know what they are doing; scientists who are senior. If the right suggestion is made then as a PI will get what you want.

Dr. Sally Heap has been an astronomer at the Goddard Space Flight Center since 1969. She has worked in developing and using astronomical instrumentation for rockets and space observatories, most notably the International Ultraviolet Explorer and the Hubble Space Telescope. Currently she is a Co-Investigator on the Space Telescope Imaging Spectrograph team and the Cosmic Origins Spectrograph on Hubble. Heap addressed the themes of this panel through her own experiences in hope that it will help the young scientists in the audience.

“You have to think things through, you have to look ahead, and you have to be clear. For instance, “these are the things that are the components of a good proposal,” said Heap. Your plan should be thoroughly researched and clear. If you are building an instrument do it correctly from the beginning and know its limitations. It is important to realize that you are part of a team. Don’t think too highly of yourself because everyone is contributing.

The lessons Dr. Heap learned throughout her career are:

- Apprentice yourself to someone who is doing something interesting.
- Think things through, be clear, and look ahead to make sure you understand how you’re going to get the scientific answer that you are seeking.
- Don’t aim to become a PI. Instead, aim to get things accomplished.
- Choose your institution wisely. This may at first be difficult but in the long run not as difficult as some of the career obstacles you will face. Remember that some institutions are very friendly but they may not be friendly to women and minorities. Do your research.

Mather opened the session to questions from the audience.

Audience Member: *I teach six courses a year at a liberal arts college. It’s hard for me to make plans, to make instruments or even to have ideas to think about what I want to explore. I want to get back into this but I never see advertisements for scientists that can do mission work, they are usually looking for post docs but I can’t give up my tenure-track job to work as a post doc. What is NASA’s view about reaching out to some of these other kinds of institutions for support from scientists who want to be involved but can’t be fully committed to being a PI or a PS?*

Jean Swank: There are programs that have university people come and spend a summer at NASA or a several year detail. There are also fellowships that you can apply for. I believe it’s called the National Post Doc Program but there are also senior ones. There are a variety of programs that you can research.

Jen Eigenbrode: Deciding to take on one of these roles in a mission is perhaps as big a decision as maybe having a family. It's not just a professional decision; it's a personal one too. How do you find any kind of balance between having one of these lead roles and your personal life?

Joe Hill: It is very difficult. It's all-consuming if you let it be. Putting yourself in space and having it be successful is difficult. It is a big team effort and requires you to spend a lot of time with this team and often away from your family. In the beginning when I was working on SWIFT it was all me, so I was happy spending as much time on it as available. I was happy to just keep going. When I got to the end of SWIFT and onto the next project and we were ramping up again, I said, "here we go again." In the meantime I had found a balance between the project and spending time with my family. It is something that you have to be careful of because there is always something that needs to be done and usually if you have a good team, everyone is able to fill in the gaps. The key thing is trying to be mindful of making sure that the job gets done but without giving up everything. I don't have a secret key to that; probably nobody else does either.

John Mather: It seems to me that people who are good at what they do try to do things themselves. One of the important things in being a project leader is to make sure that the organizational structure is better than that. If you are the leader and you are the single point failure and you don't turn up one day, your project is in big trouble. So don't do that. That said there is a little possibility for balance. Full-time over-time isn't the plan.

Joe Hill: I should have said one thing and that is that what we do is really exciting. That's the big advantage for us because our families are usually excited about what we are doing as well and want us to be successful. So keeping your family in on what you are doing is usually a good thing.

Colleen Wilson-Hodge: My question is a kind of 'what to do next' question because I started out my career doing data analysis. More recently I have been involved in instrument testing and integration of the GBM on the Fermi satellite. I found that I really like the instrument stuff. I really enjoyed all the testing. The question is that I am at Marshall Space Flight Center where there is not a bunch of instrument development going on. How do I get into the next thing? How do I get into the next phase? I would like to broaden my experience because I would like to eventually end up into a more of a leadership role.

Sally Heap: Look around and see who is doing something interesting and ask if they could use some help. I don't know of any body that has refused help. You will learn something from it—I'm sure something much unexpected.

John Mather: I think flexibility and openness to opportunity is critical. You never know when it's going to turn up.

Jarita Holbrook: I am going to ask this question in an academic manner but if you don't answer me, I'll get serious. I want to know what fights you had to undertake to become a PI. That is based on the fact that you hired me one day. That was completely random. You said, "I want to hire Jarita." That was the mid-point of my career. I know that without that opportunity I wouldn't be standing here today. And that was a completely random event. Tell me about the fights and the struggles.

Julie McEnery: That is a difficult question to answer because it all came out well in the end because I actually don't feel that I had very significant fights. But there are periods when something goes wrong and it's easy to tend to slip off into a blame game. As a Project Scientist I think it's important to try to avoid fights as much as possible. I did feel for a while when I was a Deputy Project Scientist that I wasn't being taken seriously. I would be the representative of a group of project scientists in a particular area or a particular set of meetings and yet when it came to finishing up a report or seeking further input they would seek it from other project scientists. I found that to be enormously frustrating. I felt that I wasn't being included in things sufficiently to do my job as well as I would have liked.

I now realize that people weren't intentionally side-lining me at all, that there is fairly much of a hierarchy and that people were simply reporting to the project scientist rather than to the deputy because that is what they believe is the right thing to do. I don't have much of a good answer. I actually don't feel that I have had many fights and struggles. Occasionally you have to work a bit hard to change somebody's point of view or allow somebody to change you point of view. I suspect that I am echoing everyone here largely because I have had the support of other people in the projects and from my institution.

Lisa Storrie-Lombardi: The fortitude required to survive the twenty-five years it takes from the time your instrument is selected to the time it actually works takes forever. In the meantime your institution is coming and saying we need your money so you have to justify your existence. I am impressed by project scientists and the fact that you stick with it [professions and missions]. I would like to hear your comments about this.

Sally Heap: The work and the time it takes to develop an instrument become addictive. It's because you're part of a team and you don't want to let down.

CONCLUSIONS

At this point the session had to end because of time constraints. The following list summarizes the advice the panel had for its audience. These are recommendations that can be used to achieve a high position in your scientific field but are also excellent advices for almost any profession.

- Experience counts.
- At first, your aim should be to achieve in your projects and not become a principal investigator, project scientist or instrument scientist—be humble.
- Team work and group support is essential.
- Be diverse in your interests.
- Find an excellent mentor.
- Be adaptable.
- Work with the press and public outreach experts wherever possible. Education of the general public will aid you in your projects.
- Listen to those who are more senior.
- Plan well ahead. This applies to your career, missions, projects, proposals, etc.
- Make sure you know what the outcome of a project will be and be ready to defend it.
- Choose an institution that is open minded and accepting of diverse groups.
- Work/life balance is important so choose a team than will jump in when needed.
- Involve your family in the exciting aspects of you projects.
- Last, be flexible and open to opportunity.

Images from the Conference



The WIA III 2009 was honored to have Rep. Donna Edwards, above, give the keynote address on Friday October, 23. Above right: Edwards and Laurie Leshin. Left: Dr. Jarita Holbrook (far left) and some of our attendees pose for a photo with Edwards.



Right: Dr. Howard Kea and Dr. Pamela Millar, members of the WIA III 2009 Organizing Committee.



Remembering Beth Brown



Beth's mother, Frances Brown, accepting the plaque honoring her daughter from Nick White and Howard Kea.



Beth's life was also celebrated on a poster L. to R., Jarita Holbrook, Peggy McIntosh and another meeting attendee.

Above Right: Beth's brother spoke of their childhood.



Family members and friends attended the dinner honoring Beth Brown.



Poster Sessions



WIA III, 2009 was honored to have in attendance two doyennes of the astronomy world, Nancy Roman and Vera Rubin.



Attendees of the WIA III, 2009



At every turn there was conversation.





Catching up with old friends and making new ones.



A chance to discuss issues with senior scientists.

Dinner time was an excellent opportunity for networking or posing in a picture with friends.





From left to right, three of the editors: Anne Kinney, Diana Khachadourian and Pam Millar.

III. PROPOSAL WRITING GUIDES

Writing Research Proposals for NASA

Paul Hertz, Curt Niebur, Mary Mellott, and Jim Green, Science Mission Directorate,
NASA Headquarters

SUMMARY

Writing proposals is a craft, but writing proposals for NASA might be considered a technological accomplishment. We provide some general principles for proposal writing, and then zoom in on specific guidelines that are necessary for writing and submitting successful proposals to NASA's Science Mission Directorate. The Research Opportunities in Space and Earth Sciences (ROSES) NASA Research Announcement (NRA) will be featured.

PROPOSING TO NASA

Who am I proposing to?

NASA is the premier funding agency for Earth and space science research. NASA has a ~\$600M annual Research and Analysis (R&A) budget with >50 R&A programs. Each program has anywhere from \$1M-\$10M available each year. Research is also funded through operating missions. NASA's science research programs are managed by the Science Mission Directorate (SMD), which has 4 divisions:

- Earth Science
- Heliophysics
- Astrophysics
- Planetary Science

Research Opportunities in Space and Earth Science

All NASA R&A funding is offered through the ROSES-NRA. ROSES is released annually and describes all SMD R&A opportunities. NASA SMD R&A opportunities are organized into programs described in ROSES; each program is run by a scientist at NASA Headquarters. Overlap among programs is common, but each program has its own quirks.

Types of R&A Programs

R&A programs come in different types and disciplines.

- **Fundamental Research:** Basic research that extends our knowledge of fundamental processes and benefits current and future missions.

- Instrument and Technology Development: Intended to provide advanced lab equipment, develop instruments and technologies for future missions; competition is more intense and budgets are larger.
- Data Analysis and Guest Investigator: Research focused on using new or archived mission data; often attached to a single mission, sometimes short lived.
- Participating Scientist: Intended to broaden participation in mission science teams; unique opportunities that typically occur once per mission.
- Others: Theory, mission concept studies, fellowships, education and public outreach (E/PO), history, policy, odd and unexpected stuff.

ROSES-2009

Summary of Solicitation and Appendices

The “Summary of Solicitation” (31 pages) contains (i) Funding Opportunity Description, (ii) Proposal and Submission Information, (iii) NASA Strategic Objectives, and (iv) Lists of Solicited Programs. There are five sets of appendices: A. Earth Science Research Programs (40 opportunities); B. Heliophysics Research Programs (9 opportunities); C. Planetary Science Research Programs (24 opportunities); D. Astrophysics Research Programs (12 opportunities); and E. Cross-Division Research Programs (6 opportunities; e.g. Applied Information Systems, E/PO). (Total: 524 pages)

Summary of Solicitation and Appendices

- D.1 Astrophysics Overview
- D.2 Astrophysics Data Analysis
- D.3 Astronomy and Physics R&A
- D.4 Astrophysics Theory
- D.5 GALEX Guest Investigator
- D.6 Swift Guest Investigator
- D.7 Suzaku Guest Observer
- D.8 Fermi Guest Investigator
- D.9 Kepler Guest Observer
- D.10 MOST U.S. Guest Observer
- D.11 Technology Development for Exoplanet Missions
- D.12 SPICA Science Investigation Concept Studies

WRITING PROPOSALS

What NASA wants...

NASA is looking for two things from proposals:

- To fund research of high scientific quality; for this, NASA relies on peer review.
- To ensure the research will further NASA's objectives and verify the funds will be used properly; for this, NASA relies on the program officer.

What you should expect...

What will not happen:

- You will not definitively answer the grand question plaguing the community.
- You will not write a great piece of literature.
- Your audience will not review your proposal in a quiet, uninterrupted setting.
- Your audience will not be world experts on your topic.
- Your audience will not accept your approach without question.

What will happen:

- You will answer a focused, well-posed question of limited scope.
- You will write a focused, no frills document.
- Your audience will quickly review your proposal amid the chaos of their own life.
- Your audience will be colleagues from similar fields.
- Your audience will be skeptical and critical.

What the Review Panel wants...

The Review Panel is primarily interested in the scientific merit of the proposal. Pick a compelling and appropriate topic of proper scope; describe the objectives and end result of the work; describe your methodology and identify your assumptions; provide a detailed work plan describing who does what and when; anticipate questions and answer them; and logically link the objectives, methodology, and anticipated results to one another and to NASA's objectives.

What the Program Officer wants...

The Program Officer is primarily interested in the programmatic merit of the proposal. So, read the NRA and respond to it; propose high quality science; do not "supersize" the proposal; organize proposal into discrete tasks; link proposal objectives to NASA objectives; provide a detailed budget with proper justifications; and follow the Guidebook for Proposers. NASA's objectives.

Where you should start...*The Guidebook for Proposers*

NASA standard requirements for all R&A proposals are given in the Guidebook for Proposers Responding to NASA Research Announcements (“the Guidebook”). The Guidebook tells you what information the proposal needs to be selected and how to present that information to make the job of the Review Panel and Program Officer easier. It is at NSPIRES (<http://nspires.nasaprs.com/>) and at <http://www.hq.nasa.gov/office/procurement/nraguidebook/>.

Guidebook Contents

The Guidebook for Proposers contains sections on (1) Overview of NASA Research Announcement (NRA), (2) Proposal Preparation and Organization, and (3) Proposal Submission Procedures. It also has appendices on (A) Guide to Key Documents on the World Wide Web; (B) Instructions for Responding to NASA Research Announcements; (C) Proposal Processing, Review, and Selection; (D) Proposal Awards and Continued Support; (E) Certifications, Sample Agreements, and Forms; (F) Frequently Asked Questions; (G) Security Requirements, and ; (H) Process for Appeals.

Helpful Hints from Section 1.7 of the Guidebook

- Follow the instructions in the specific NRA element of interest.
- Clearly state the objectives and implementation plan.
- Provide appropriate recognition of preceding accomplishments; show how the proposed activity will extend and build on what has already been done.
- Proofread carefully and ask a colleague to critically review it.
- Use legible fonts and illustrations and a clear, simple organization.
- Strive for realism as well as adequacy of the budget and provide the details necessary to justify the proposed costs.

Suggestions:*Before you start writing...*

- Sit down, think through, and plan the research before writing the proposal.
- Demonstrate the feasibility of the approach, especially if looking for something new or in a new way.
- Stay focused—avoid “supersizing” the proposal.
- Ignoring weaknesses will not make them go away; burying them with irrelevant details will not hide them.

- Even though you give good talks, you can't expect the review panel to remember those talks or give you credit for them. Review panel reviews the proposal, period.

When you are writing...

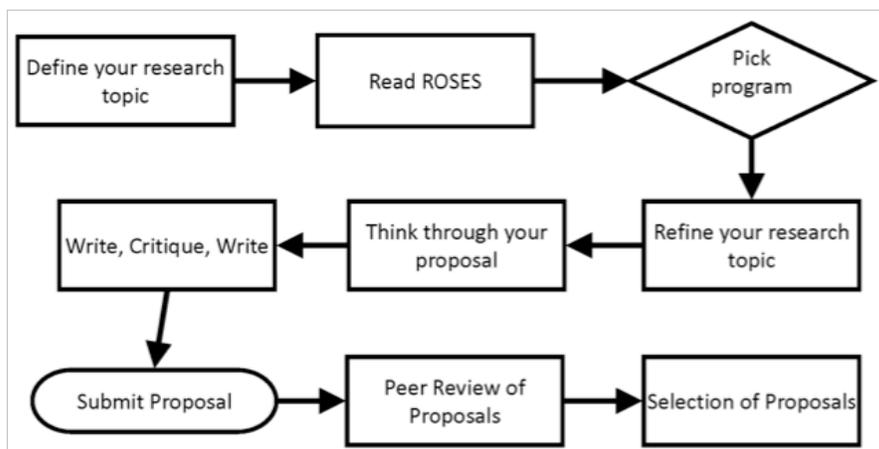
- Write clearly and simply—avoid hyperbole.
- Organize the proposal well and follow the Guidebook for Proposers.
- Provide the reader with clear signposts throughout the proposal.
- Thoroughly review and cite the relevant literature.
- Use graphics and tables effectively for impact.
- If you propose multiple tasks, explain the interrelationship among them.
- State if you are proposing the same research to two or more programs.

After you think you are done writing

At the end of the day you need to convince the panel that:

- The research is very important.
- It is directly relevant to NASA's mission.
- It is directly relevant to the solicitation.
- Your proposed methodology is both feasible and appropriate.
- You will deliver valuable results.
- It is well worth the investment.
- After your proposal is selected
- Serve on a review panel.
- Stay in touch with the Program Officer regarding funding receipt.
- Submit your Progress Report on time.
- Plan far ahead if you have a critical deadline for receipt of funds.

THE PATH TO SUCCESS



NSF Proposals: How Not to Get Funded

Compiled by **Diana Khachadourian**, ASRC/GSFC, from the poster presented by **Dana Lehr**, NSF

Each year, the National Science Foundation's Division of Astronomical Sciences receives over 800 proposals. Of these, about one in four will be awarded. So, how does one write a proposal that will review well? Just about anyone can give you advice about *that*—but this paper will give you some tips on how to do it *poorly*.

The following tips are presented to you “tongue-in-cheek” as rules to help you submit a losing proposal. By focusing explicitly on sure-fired ways to have your proposal rejected, I hope the path to successful proposal writing will be all the more clear.

1. HOW NOT TO GET FUNDED: THE FAST PATH

The following proposal violations are fatal. If you would like your proposal to be returned quickly, unread, and with a note from your program officer telling you how sorry they are but their hands are tied, please do one of these:

Have more than a one page Project Summary

You are allowed one page at the beginning of the proposal to summarize the intellectual merits and broader impacts of your proposal. Anything longer than one page is a great way to have your proposal rejected immediately.

Have more than 15 pages of Project Description

You are allowed fifteen pages to talk about your project and the good things that will come of it. Go ahead and write more than fifteen pages. This will allow the panel to reject your proposal without any hesitation.

Leave out any discussion of postdoc mentoring

If you will be needing extra funding to include the help of a postdoc for your project, don't write about mentoring them in career planning, preparation of grant proposals, publications and presentations, ways to improve teaching, how to effectively collaborate with researchers, and training in responsible professional practices. This requirement was new in 2009, so no one will blame you for leaving it out; NSF will just return the proposal.

Do not discuss Broader Impacts in your Project Summary*

(*NOTE: This is the number one cause of proposal returns!)

You are submitting to the NSF, not the National Broader Impacts Foundation, right? It turns out these are taken very seriously, and if you don't include them in your summary, your proposal will be returned.

Do not discuss Broader Impacts in your Project Description

Why give up precious space to talk about Broader Impacts, especially after you have devoted an entire paragraph to them in your Project Summary? After all, there are two review criteria – intellectual merit and broader impacts – do you really need to worry about both of them? Not only will the reviewers probably downgrade the proposal if Broader Impacts are missing from your Project Description but, in the future it may be sent back unread..

Do not include Results of Prior Support in your Project Description

Do not include support you or your co-PIs have received from NSF in the past five years. You would not want to impress the reviewers with results from your prior work, would you? Omitting such information will make it all the more easy to reject your proposal. In future, NSF may even return it unread..

2. HOW NOT TO GET FUNDED: THE SLOW PATH

If you would like your proposal to go to review before not getting funded, try some of the following:

Cram as much into the Project Description as possible

This is also known as, “My project is so interesting, no one will mind” or “Oh, rarely have the words poured from my penny pencil with such feverish fluidity.” There is nothing reviewers like more than rambling prose that isn’t concise and to the point, so the more words you can use, the better. Along these lines, below are some tips for making room for all your prose.

Use the smallest possible font size

Most reviewers read proposals on their computers instead of printing them out. And the Acrobat Viewer has a zoom feature, so tiny type does not matter. Besides, picking up a proposal out of a stack of 30 that need reading before the meeting and seeing all that tiny type makes a great first impression. Not.

Use slightly smaller margins

If you need extra room, cheat on the margins. Nobody will notice because they will be distracted by all the words you are using. Really. Reviewers like this approach so much that it may soon join the fast track to non-funding.

Make the figures really small

A picture may be worth a thousand words, but why not use both? Legible axes and distinguishable markers for different data points are over rated. And again, Acrobat does have a zoom feature!

Cut your proposal budget until you can't do the project

Project Resources are an important consideration. So a good way to make sure your proposal isn't successful is to come up with a budget that cuts things like page charges for publications, support for your time, travel to observatories (if you'll be observing), and money for the postdoc who will be helping wade through the code.

Cite papers that you really, really expect to be in journals by the time your proposal is reviewed

Odds are you'll get to it. And what could go wrong—especially if important parts are in the hands of collaborators?

Don't download the completed proposal to make sure it's OK

The odds of your uploading the wrong version of your Project Description are pretty low, right? Likewise, Fastlane never has any formatting errors. Ever. Trust the proposal will look exactly like what you expect and you are on the road to proposal rejection.

Don't proofread

“Never proofread. Sloppiness is not an issue in comm.plx endeavours.” Right?.

There is no need to put your work into context

The entire panel will be super-experts in the minutiae of your field. For example, there will be an entire panel devoted to the composition of NGC 104, right? So, it's OK to jump right in because the broader problems and longstanding questions that your work will address will be obvious to all. Or if this is not the case, you will quickly be rejected.

Last but not least...

Above all, no matter what you do, don't talk to your Program Officer. They might actually offer advice, tips, or ideas for funding. It's also not a good idea to try to sit on some panels to get a feel for what successful proposals look like. Instead, listen to what the person down the hall, who got a grant 15 years ago, has to say. Nothing has changed. Really.

3. CONCLUSION AND WHAT TO REALLY DO!

If you prefer a chance to receive funding from the NSF to that of having your proposal returned without review, heed the most current version of the NSF Grant Proposal Guide. Remember, there is no guarantee, but adhering to the guidelines will definitely give you a better chance than not adhering to them. Make sure to read instructions carefully; they are there for a reason. To get complete information, go to <http://www.nsf.gov/funding/preparing>.

It is extremely important to get advice from someone who has applied for NSF funding in the recent past — and preferably received an award. Ask them to review your writing to make sure you have been clear and concise.

Make your points plainly and simply. You are not writing a novel, but you still must write well. Proofread and then have others look at your submission for corrections and comments. We often do not see our own typos.

If you will be using a postdoc in your research, do tell the NSF how he or she will benefit from the project and how you will mentor them.

It is important to mention past achievements, especially if you have received funding from the NSF in the last five years.

Provide the broader context of your proposed research so that a general audience of professional astronomers may understand how it fits into the field. Address both the intellectual merit and broader impacts of your proposed activities, both in the Project Summary and in the Project Description. However, do not deviate too far from your topic. Make sure your text is on point, cogent, and coherent.

Don't cheat on spacing; the readers and evaluators have seen this before — smaller margins and smaller fonts are not acceptable. Make sure that your figures, graphs, etc. are legible; don't skimp on their size because you want to add more text. Say what you want with fewer words.

The rules and criteria for funding are constantly changing, so read carefully, write thoughtfully, and talk to your Program Officer for sound advice and suggestions.

GOOD LUCK!

IV. PROGRAMS FOR SUCCESS

Astrobiology Research Experience for Undergraduates: An Interdisciplinary REU Program at the SETI Institute

Cynthia B. Phillips, SETI Institute and **Edna K. DeVore**

SUMMARY

The SETI Institute's astrobiology Research Experience for Undergraduates program brings together undergraduate students from around the country for a ten-week research experience in the San Francisco Bay Area. The program includes students from a broad range of backgrounds, and focuses on recruiting a diverse population of students from every state. The program targets the recruitment of members in underserved minority groups. More than half of our participants have been female, and many have gone on to graduate school in a variety of fields.

INTRODUCTION

The Search for Extraterrestrial Intelligence (SETI) Institute hosts a summer Astrobiology Research Experience for Undergraduates (REU) program for highly motivated students interested in astrobiology research. Students work with scientists at the SETI Institute and at the nearby NASA Ames Research Center on projects spanning the field of astrobiology from microbiology to planetary geology to astronomy and astrophysics. Each student is mentored by a scientist for his or her summer research project. Because astrobiology is interdisciplinary, the first week includes a seminar series to provide a broad foundation in the field as the students begin their research projects. The ten-week program includes a weeklong field trip to the SETI Institute's Allen Telescope Array, located at the Hat Creek Radio Astronomy Observatory in Northern California, and a field experience at hydrothermal systems at nearby Lassen Volcanic National Park. Students also participate in local field trips to places such as the California Academy of Sciences and other nearby locations of scientific interest. They also attend seminars, lectures, and discussions on astrobiology. Students are also invited to attend events at nearby NASA Ames Research Center, which offers the opportunity to interact with other undergraduate and graduate students participating in NASA summer programs. At the end of the program, students write up and present their research projects, and mentors recommend some projects for submission to a national scientific conference, which the selected students will be funded to attend.

RECRUITMENT

Each year the website lists the summer projects, and as a part of their applications, students select the three that most interest them. Applications are due in early February. Typically, ten students apply for each available position. Students have been selected from colleges and universities national-wide, ranging from R1 research universities to community colleges. Approximately fifteen students per year participate in our program.

We recruit widely, via direct email solicitation to astronomy, physics, biology, chemistry, and geology departments at colleges and universities in every state. We specifically target recruitment not only at large research universities, but also at Historically Black Colleges and Universities (HBCU's): minority-serving and Hispanic-serving institutions; small liberal arts colleges; Native American Tribal colleges; rural colleges, and other institutions that may lack resources or facilities to involve undergraduate students in scientific research.

We advertise our program at national professional meetings such as the American Astronomical Society and the American Geophysical Union fall and winter meetings, as well as recruiting events specifically geared towards minority and underserved student populations.

The Astrobiology REU program emphasizes three main areas. Typical project themes include:

- **Biochemistry and the Origin and Evolution of Life in the Universe**
 - Biologically accessible carbon
 - UV resistant microbes
- **Planetary Science and the Search for Life in the Solar System**
 - Titan geology and fluvial geomorphology
 - Mars geomorphology and spectroscopy
- **Astronomy and the Search for Extraterrestrial Intelligence (SETI)**
 - Meteor showers and their parent comets
 - SETI and radio astronomy

DEMOGRAPHICS

The SETI Institute Astrobiology REU program has served four classes of students, and is funded through summer of 2011. A total of 61 students have participated: 12 in 2006; 17 in 2007; 17 in 2008 and 15 in 2009. All participants have successfully completed their internships. Of these students, 59% were women, and 21% were minorities.

A feature of our REU program, like several other internship programs, is that more than half of our participants have been women. Thirty-six female students and twenty five male students have participated in the first four years. Most of the time, students are paired up and work one-on-one with a SETI Institute scientist. Perhaps unusual among astronomy research organizations, the SETI Institute has a large number of female scientists, and we have recruited many of these scientists to serve as mentors and role models to the REU students. Over the past four years, we have had twelve female mentors and eighteen male mentors in the program who have participated for one or more years. However, we have not made a particular effort to match female students with female mentors, feeling that it is just as important for male students to learn from strong female role models as it is for female students. The SETI Institute REU program PI, Cynthia Phillips, makes a point of mentoring all students as well, with a particular interest in modeling work/life balance. She has held informal group discussions on options for women in science and continues to mentor students remotely well after they leave the program.

We have had student participants from a variety of racial, ethnic, and economic backgrounds, and make an effort to encourage all students to learn from each other. We intentionally pair students from diverse backgrounds as roommates, and have found that students from small rural colleges or large state schools have learned that they are just as smart and capable as students from Ivy League universities, and vice versa. Many students have never been to a large cosmopolitan area like the San Francisco Bay Area. This can also be an eye-opening experience that helps break down cultural barriers and stereotypes.

We have had students attend the Gay Pride parade in San Francisco while others have experienced multiethnic foods for the first time. A student from Iowa commented that one of the things she would miss most about the Bay Area was Chinese and Thai food, which she had for the first time over the summer. For an East Coast student, the trip to California was the first time he had ever been on an airplane. And for a student from Oregon, the REU program was the first time she had been in a group of her academic peers—she said that for the first time, she wasn't afraid that she would be mocked for raising her hand to answer a question during a lecture. The students grow and mature noticeably during the course of the ten-week program, and many have continued to stay in touch during the following academic year and beyond.

BEST PRACTICES AND LESSONS LEARNED

At the end of each of the past four years of our REU program, we have conducted formal evaluations of various program aspects as rated by both students and mentors.

We have made adjustments to many program features based on these evaluations.

Our best practices include:

- Scheduling the weeklong field trip to the Allen Telescope Array at Hat Creek Radio Observatory (HCRO) and Lassen Volcanic National Park during the third week of the program enhances student bonding early on. Students live together in dorms at HCRO and cook shared meals. Uninterrupted research time is then available for the remainder of the summer. Students share a large office for the summer that encourages collaboration and reduces isolation.
- Our structured program builds research and presentation skills throughout the summer; students give practice talks and are evaluated by their peers and mentors in preparation for their final talks.
- A significant aspect of REU summer programs is immersion into the world of a scientist. Students participate in research projects, perform lab work, go on observing runs or field work, read journal articles, attend scientific lectures and seminars, and finish their projects with an oral presentation and a written research report that are designed to emulate the abstracts and talks given at professional conferences. By the end of the summer, students are well aware of what a life in scientific research looks like, and can decide if such a career appeals to them (or not!).
- Our interdisciplinary program forces students (and scientists) from very different research backgrounds to talk to, and learn from each other. The biologists learn about radio astronomy, and vice versa. One physics student, who worked on a planetary geology project for the summer realized that she loved that subject and decided to change her major to also include geology. The emerging field of astrobiology and other such topical subjects will require flexible students who can embrace a wide variety of disciplines, and programs like ours begin to break down traditional barriers between fields.
- Our application process is innovative. We list research projects on the application website, and ask applicants to rank their top three research projects on their application. Then, mentors rank their top candidates, beginning with those applicants who chose the mentor's project at their first choice. We have found that this system, while somewhat complex, produces the best matches between students and research projects, enhancing student interest and satisfaction with the summer research experience.

ON TO GRADUATE SCHOOL

To date eighteen students have gone on to graduate studies, in Master's or PhD programs at schools that include Harvard, UC Berkeley, UC Santa Cruz, Stanford, Univ. of Nebraska, and many others, in fields including astronomy, optical science, space life sciences, geology, physics, mechanical engineering, and molecular and cellular biology. Many more students are still undergraduates and will be applying to graduate school in coming years.

We continue to track and mentor our students after the summer program, keeping in touch via email and in person at various conferences. Research has shown that, while astronomy-related REU programs often have a majority of female students, the percentage of women decreases at every step after graduate school through post-docs, faculty, and research positions. We will continue to provide mentoring, support, and strong role models for the female students and the members of underserved minorities in our program, to help encourage them to follow their research dreams as far as they desire.

FOR FURTHER INFORMATION

2010 SETI Institute Astrobiology REU Program information:

- *The 2010 REU program dates were June 6, 2010, through August 14, 2010*
- *More information, 2010 research projects, and the online application for 2011 will be available on the SETI Institute REU website by early December*
- *Applications will be due in early February, and notifications of selected students will take place in March*

For more information, please visit: <http://www.seti.org/reu>

Funding and Support: The SETI Institute is a non-profit scientific research institution located in California's Silicon Valley. The NSF Grant AST-0852095, funds the SETI Institute Astrobiology REU program, with additional support from the NASA Astrobiology Institute, NASA Educational and Public Outreach supplements, and private donors. Equipment and software were provided by Sun Microsystems and ITT Visual Information Solutions.

We would also like to acknowledge the cooperation of NASA Ames Research Center for joint programs, as well as the support of the scientists and staff members at the SETI Institute. A program of this scope would not be possible without the significant donations of time by the mentors who volunteer to work with students, the SETI Institute facilities, IT, and HR staff who support the program, and the Education and Outreach department's assistance with student recruitment, program logistics, and many other aspects.

Women in Astronomy at Gemini: A Success Story

Bernadette Rodgers, Inger Jorgensen, Neil Barker, Michelle Edwards, Gelys Trancho,
Gemini Observatory

SUMMARY

Gemini Observatory has been very successful at attracting, hiring and retaining female scientists. We present data on the growth of the scientific staff since the start of the observatory, and science fellow recruiting from 2006-2008. At Gemini 31% of the science staff having PhDs are female compared with 13.9% [1] within the United States. The Science Management is 75% female, as is 50% of the Gemini Directorate.

This critical mass of female representation within the science staff and management appears to have had a positive effect on female recruitment and hiring; in 2006-8, 21%-38% of science fellow applicants were female and 57% of new hires during this period were women scientists. Perhaps even more significant, the retention rate of female science staff at Gemini is 88%, compared to 64% for male science staff. There are likely many factors contributing to this success, but we conclude that Gemini is a place where female scientists are valued and can be successful.

GEMINI SCIENCE STAFF

Gemini has had female PhD scientists since the beginning of science operations, and has consistently maintained a fraction of female PhDs between 25% and 35% (fig. 1). This is well above the percentage of female astronomers and physicists in the US (19.1% in 2000 [1]). It is likely that the relative youth of the organization is the primary reason for this—nearly all of the staff has been hired in the last 10 years, during which time the percentage of females among new PhDs has grown from $\approx 20\%$ to 29% [2]. As a new Observatory starting from scratch, Gemini has been able to tap into a diverse and more gender-balanced labor pool. As an example, Gemini has just four tenured staff with two women, compared to 18 tenured faculty with two women at NOAO [3]. Our international partnership also contributes to the diversity of our workforce; there are no less than fifteen nationalities represented among ~ 45 PhD staff. It is also likely that the presence of women science staff, and managers, contribute to continued growth and retention, simply by providing a visible female presence and a clear signal that women scientists can and do advance at Gemini.

FEMALE LEADERSHIP

Women are present at all levels of the Gemini science staff. There are women science fellows, scientists, tenure-track and tenured astronomers, supervisors, and managers.

Most of the senior positions, including the Heads of Science at both telescopes, were internal promotions based on performance and ability. In August 2009, Nancy Levenson joined Gemini as Deputy Director and Head of Science, further increasing the female representation in the Gemini leadership.

RECRUITING AND HIRING

The Gemini hiring process selects the best person for a job, independent of gender, race, age, etc. The percentage of female Science Fellow applicants in 2006-2007 was slightly lower, but consistent with, the gender ratio of new US PhDs (28% female in 2006 [2]), as would be expected for this entry level position. But in 2008, we saw a significant increase in female applicants (fig. 2). Without polling the applicants, it is impossible to know if the presence of women on staff was a factor in this increase. In an informal survey of current women astronomers on staff, none cited gender as a primary factor in applying or selecting Gemini. However, when asked, three out of nine hired since 2005 agreed that it was a positive factor in their decision, whereas none of the six staff that started before 2005 felt this way. The bottom circle in Fig. 2 shows that just over half of the hired science fellows over the same period were female (four of seven total, note the small number statistics). All of these selection committees included male and female members.

RETENTION

The 31% female science staff is not only due to hiring, but also to retention. THERE IS NO LEAKY PIPELINE AT GEMINI. The retention rate of female science staff is 88%, compared to 64% for male science staff. Every female PhD scientist hired in 2005 or before has been promoted (some more than once). Among the women PhD scientists interviewed, the majority (73%) cited the presence of many women science staff as a positive factor in working at Gemini, and 87% either have already been at Gemini for several years, or stated that they could see themselves staying for a long time. When asked, several listed common gender-related concerns that remain in Astronomy as a whole, such as family issues due to shift and travel schedules, or at Gemini in particular, most notably the lack of female engineers (just 4.3% of the engineering staff is female). Still, the majority of the comments were positive.

Some examples:

“I like that...it’s not unusual to have more than one woman in a meeting.”

“It takes all kinds to do a good job...different genders and personalities working together get the best results.”

“The balance is good, and makes me feel more comfortable.”

“The large number of women here creates a supportive environment.”

“I like to see women in manager positions... [some] male staff complain that women are treated so well at Gemini.”

CONCLUSION

The authors thank the Gemini staff that agreed to be interviewed for this poster. Having the benefit of writing this contribution after the conference, the authors would also like to thank the organizers for the stimulating exchange that took place at the third Women in Astronomy and Space Science conference. There was much discussion about diversity and about changing the culture. In this regard we point out that the relative success achieved at Gemini Observatory is not the result of any special program or magic bullet. Rather, it derives from our management and staff who understand that diversity fosters excellence. Ensuring that our hiring and promoting practices are inclusive to all guarantees that our staff is truly the most talented available, and diversity is achieved naturally through our pursuit of excellence. And so we encourage the reader to “be the change you want to see.” Change comes from within, and it is up to each of us to develop our field as we would like it to be—to reward mentoring, outreach, those that embrace diversity, and excellence in all aspects of astronomy.

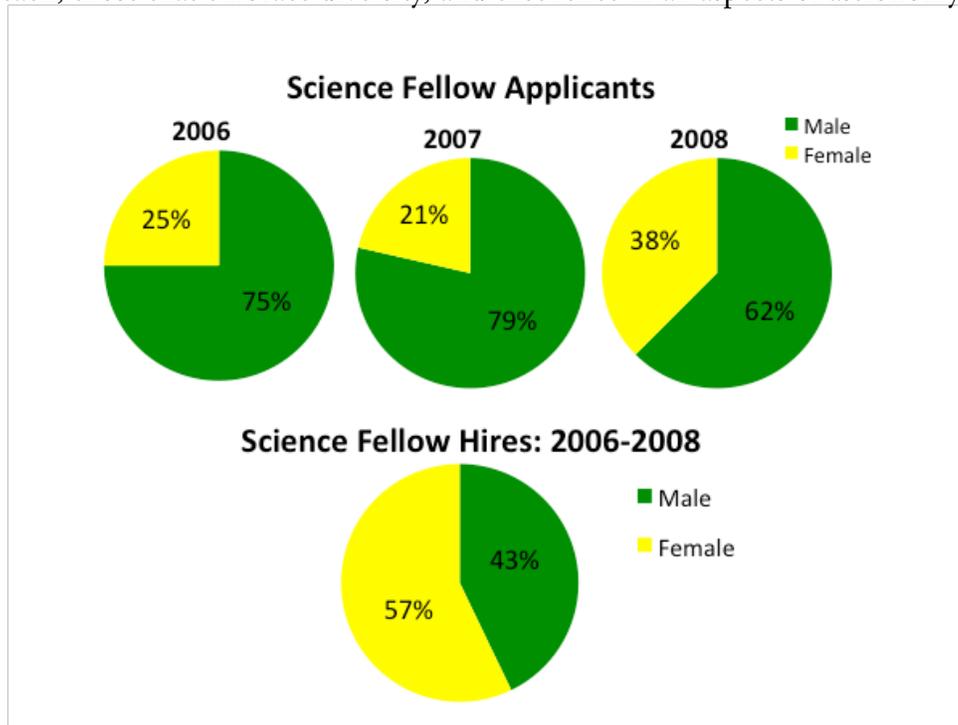


Figure 1. Science fellow applicants (above) and hires (below) by gender, 2006-2008.

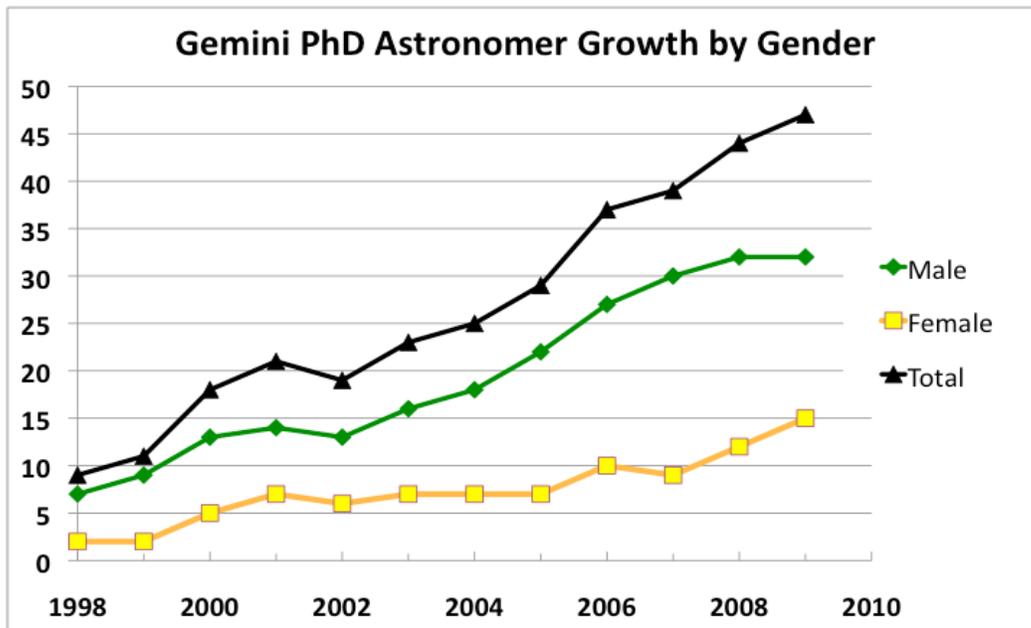


Figure 2. Number of PhD Astronomers on staff by year and gender.

REFERENCES:

1. U.S. Census, 2000: <http://www.census.gov/eo2000/> (occupation astronomers & physicists)
2. NSF 09-311: <http://www.nsf.gov/statistics/nsf09311/> (data tables 1&2)
3. NOAO staff directory: <http://www.noao.edu/staffdir/> “Diversifying the next generation of astronomers...” by A. Nota et al (a 2010 Decadal Survey position paper) provided additional background and insight.

The Fisk-Vanderbilt Master's-to-PhD Bridge Program: Broadening Participation of Underrepresented Minorities in Astronomy through Research-Based Partnerships with Minority-Serving Institutions

Keivan Guadalupe Stassun, Vanderbilt University and Fisk University, Nashville and
Kelly Holley-Bockelmann, Vanderbilt University and Fisk University, Nashville

SUMMARY

We describe the Fisk-Vanderbilt Master's-to-PhD Bridge program as a model for effective partnerships with minority-serving institutions to broaden participation of underrepresented groups in the physical sciences. The program couples targeted recruitment with active retention strategies, and is built upon a clearly defined structure that is flexible enough to address individual student needs while maintaining clearly communicated baseline standards for student performance. A key precept of the program philosophy is to eliminate passivity in student mentoring; students are deliberately groomed for the transition to the PhD program through active involvement in research experiences with future PhD advisers, coursework that demonstrates competency in core PhD subject areas, and frequent interaction with joint advising committees. This allows student progress to be monitored effectively and performance to be evaluated holistically. Since 2004, the program has attracted a total of 31 underrepresented minority students (59% female), with a retention rate of 92%. Recent research indicates that minority students are nearly twice as likely as non-minority students to seek a Master's degree en route to the PhD. In essence, the bridge program described here builds upon this increasingly important pathway, with a dedicated mentoring process designed to help ensure that the Master's-to-PhD transition is a successful one.

1. INTRODUCTION

The underrepresentation of minorities in the space sciences is an order-of-magnitude problem, and is one of the major challenges facing the nation's science, technology, engineering, and mathematics (STEM) workforce as a whole (National Science Board 2003). Black-, Hispanic-, and Native-Americans comprise more than 25% of the U.S. population, yet represent only ~3% of all astronomy and astrophysics PhD's earned (Survey of Earned Doctorates (SED), a national survey conducted for six federal agencies). In raw numbers, this translates into an average minority PhD production rate of

about five individuals per year. Put another way, each of the roughly 50 astronomy and astrophysics PhD programs in the U.S. has an average PhD production rate of one underrepresented minority every ten years (Stassun 2005). This pattern of underrepresentation has remained largely unchanged for the past 30 years. Significantly, only about 40% of all PhDs earned in space science related disciplines are awarded to U.S. citizens and permanent residents (SED).

Minority-serving institutions are important producers of domestic minority talent in the sciences. Roughly one-third of all STEM baccalaureate degrees earned by African-Americans are earned at Historically Black Colleges and Universities (HBCUs), and the top 15 producers of Black baccalaureates in physics are all HBCUs. Just 20 HBCUs were responsible for producing fully 55% of all Black physics baccalaureates in the U.S. from 1998 to 2007 (e.g. Norman et al. 2009). Institutional partnerships with HBCUs are thus a promising avenue for broadening participation in the physical sciences (Stassun 2003). At the same time, recent research on the educational pathways of minority students in STEM disciplines indicates that these students are roughly twice as likely as their non-minority counterparts to seek a master's degree en route to the doctorate (Lange 2006). These facts motivate programmatic approaches aimed at deliberately preparing underrepresented minority students for success as they traverse the critical Masters-to-PhD transition.

Here we describe a program developed in partnership between Vanderbilt University, a PhD-granting R-1 university, and Fisk University, a research active HBCU, both in Nashville, Tennessee. The Fisk-Vanderbilt Master's-to-PhD Bridge Program (see www.fisk.edu/bridge) is for students who seek additional coursework or research experience before beginning PhD-level work. The program provides a continuous path—a bridge—to the PhD that we have found is particularly effective for students whose baccalaureate degrees are from small, minority-serving institutions, and who may for a variety of reasons seek a master's degree en route to the PhD. The program is flexible and tailored to the goals of each student. Courses are selected to address any gaps in undergraduate preparation, and research experiences are designed to pave the way for PhD-level work in the chosen area of study. While at Fisk, students enjoy regular interaction with Vanderbilt faculty including access to Vanderbilt courses and, of critical importance, thesis research performed under the joint supervision of Vanderbilt and Fisk faculty. In all cases, we deliberately develop research-based mentoring relationships between students and faculty that will foster a successful transition to the PhD.

2. THE IMPORTANCE OF MASTER'S-TO-PHD TRANSITIONS FOR MINORITIES

Master's education is a growing enterprise in U.S. colleges and universities. Much of that growth has been attributed to the entrance of students of color. In the decade between 1990 and 2000, the total number of master's degree recipients increased by 42%. During this same time period, the number of women earning master's degrees increased by 56%, African Americans increased by 132%, American Indians by 101%, and Hispanics by 146% (Syverson 2003).

A recent study by Lange (2006) provides critical new insight into the role of the master's degree as underrepresented minority students proceed to the doctorate in STEM disciplines. Data from the SED was used to examine institutional pathways to the doctorate, and transitions from masters' to doctoral programs by race and gender, for a sample of more than 80,000 PhDs.

As shown in Figure 1, Lange (2006) identified six primary pathways to the PhD. Statistical analysis reveals that pathways are significantly different for underrepresented minorities ($\chi^2=49.1$, $df=18$, $p<0.001$). The two major differences are that White/Asian students are more likely to forgo earning the master's degree altogether ("No MS, BA \neq PhD" in Fig. 1), and underrepresented minority students are much more likely to earn all three degrees at three different institutions (BS \neq MS \neq PhD). Underrepresented minority students are thus more likely to use the master's degree as a stepping-stone toward success at the PhD level. Unfortunately, very often the transition from master's degree to PhD is one that students must navigate on their own.

3. THE FISK-VANDERBILT MASTER'S-TO-PHD PROGRAM

Admission begins with application to the Fisk MA program in physics, which includes undergraduate transcripts, letters of recommendation, a personal statement, and general GRE scores. The applicant indicates on the application that they wish to be considered for the Bridge program and submits an additional Bridge program information form. Once admission to the Fisk MA program has been formally decided by the Fisk faculty following Fisk's standard admissions procedures, admission to the Bridge program is determined by the Bridge program steering committee, consisting of three faculty members each from Fisk and Vanderbilt. Upon the recommendation of this steering committee, the successful applicant is formally designated as a Bridge student.

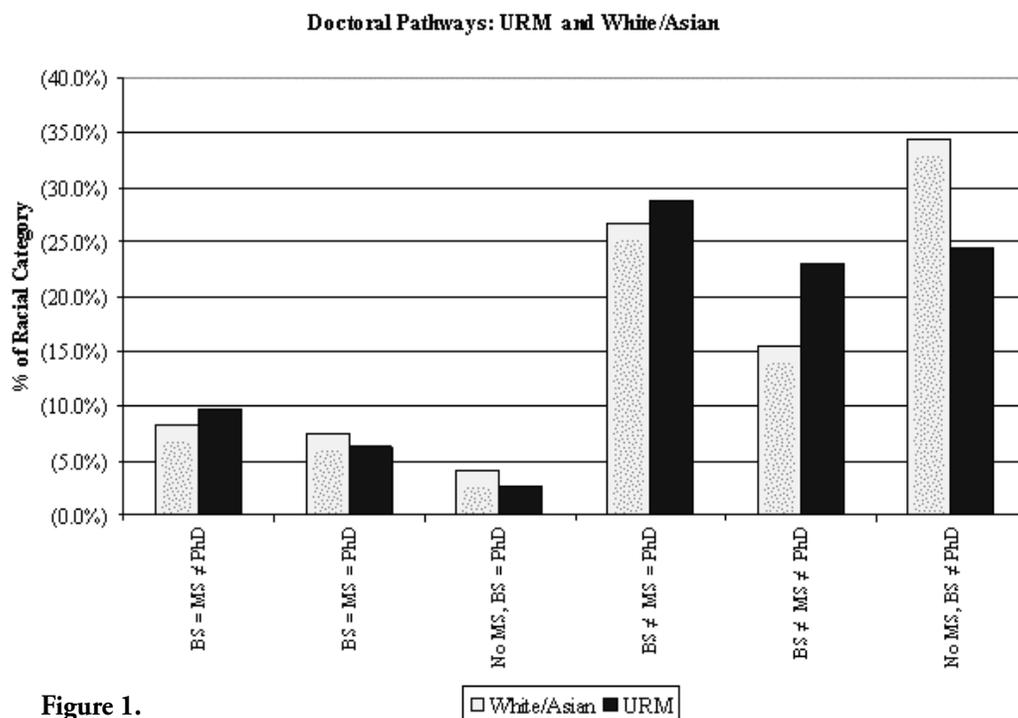


Figure 1.

Figure 1. Comparisons between underrepresented minorities and White/Asian students, based on different permutations of the educational pathway to the PhD. An equal sign indicates degrees earned from the same institution. The fourth and sixth comparisons from the left show the “traditional” paths to the PhD, in which the student earns the bachelor’s degree from institution A, and either receives both the master’s degree and the PhD from institution B or else forgoes the master’s degree entirely. The fifth comparison from the left is shown the case for earning the bachelor’s degree at institution A, a “terminal” master’s degree at institution B, and PhD from institution C. Minorities are much more likely to take this latter path than non-minorities. Based on analysis of 80,739 PhDs earned in science and engineering fields, 1998 to 2002. Adapted from Norman et al. (2009).

3.1. Facilitating a Successful Transition to the PhD

The vehicle by which successful transitions to the Vanderbilt PhD program is realized through carefully orchestrated student-faculty mentoring relationships focused on research. We have found that the extent to which a student is successful in developing one-on-one research-based relationships with faculty mentors—mentors who may very well become the student’s PhD advisor—is the single most reliable predictor of the student’s eventual admission into the Vanderbilt PhD program. Faculty mentors not only provide key guidance on course selection and research topics, they also become the

student's most important advocates in the PhD admissions process. The fact is that a student who is well known to the faculty of the admitting department is more likely to have their potential for success evaluated on the basis of direct faculty interaction, and not simply on how the student appears "on paper."

- Participation in supervised research, at Fisk or Vanderbilt (or both), during at least the second academic year of the program, and participation in supervised research at Vanderbilt (or at an affiliated research site) during at least each summer of the program. Students are required to produce a publication-quality master's thesis.
- Assignment of both a Fisk advisor and a Vanderbilt advisor. Joint mentoring allows tracking of student progress and helps to ensure student readiness for PhD-level work.
- Scheduling of at least two meetings per year with the Bridge program steering committee to review progress and receive guidance, in addition to the day-to-day interactions with primary faculty advisers. This helps keep key personnel abreast of student progress, helps to keep each Bridge student on the PhD program's "radar screen," and helps PhD program directors in planning the needs of each year's incoming PhD class.
- Requirement of at least B grades in all graduate courses, with at least one of these courses being a core PhD course taken at Vanderbilt. This allows the student to demonstrate competency in a core PhD course, which is essential to demonstrating promise for PhD study. Typically, Bridge students take several core PhD courses at Vanderbilt. Together with a judicious selection of courses taken in fulfillment of the MA degree at Fisk, many Bridge students complete most of the course requirements for the PhD by the time they apply to the Vanderbilt doctoral program.

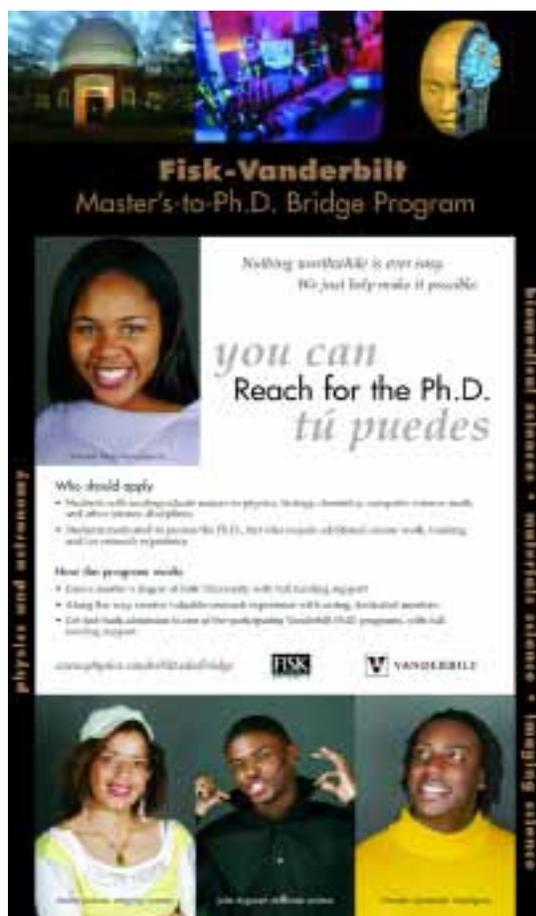


Figure2: Recruitment poster and brochure for the Fisk-Vanderbilt Master's-to-PhD Bridge Program. See www.vanderbilt.edu/gradschool/bridge.

3.2. Underlying programmatic “theory”

In collaboration with researchers at Columbia University’s Center for Institutional and Social Change, we have identified two core principles that guide our development of the program. The first relates to recruitment, the second to retention.

Recognizing and nurturing unrealized potential in students: Passively waiting for that rare candidate who stands out by all of the usual metrics on paper will not net a high yield of promising new recruits. As discussed by Dr. Richard Tapia in his 1999 address to an NSF-sponsored summit on “Promoting National Minority Leadership in Science and Engineering,” a business as usual approach, particularly in admissions, simply does not achieve the goal of truly broadening participation. In his remarks, Dr. Tapia suggests that instead of simply competing with other highly-ranked schools for the best students, truly broadening participation requires that we identify and support the second pool, the “diamonds-in-the-rough that don’t look like traditional candidates.” This second pool consists of individuals who are certainly talented and capable, and can succeed given proper guidance, but who either have not been properly developed or properly evaluated. It is this second pool that our traditional graduate programs have been missing. As Dr. Tapia points out, “They take special effort. They require mentoring, guiding, and sometimes remediation. They may make a slower start.”

In formulating our admissions strategy, we have been forced to abandon the usual mindset of filtering applicants on the basis of proven ability to one of identifying applicants with *unrealized potential* that can be honed and nurtured.

Recognizing that potential takes a number of forms, and often plays out differently for each student. One student’s undergraduate transcript might show a low GPA that, on closer inspection, is the result of a slow start but a clear upward trajectory. Another may have an excellent GPA but missing upper-level courses in the major because they were simply not available at the undergraduate institution. Still another may simply have made a strong positive impression on a faculty recruiter during a poster presentation at a national conference. At the same time, we have formed strong, positive relationships with colleagues at numerous minority-serving institutions. As we get to know these undergraduate programs better, we are able to make more informed evaluations about specific strengths and weaknesses of incoming students. In a report studying strategies for building effective partnerships with minority-serving institutions, Stassun (2003) found that undergraduate mentors at these institutions take a very active role in advising their students, and will actively steer their students away from graduate programs that they do not trust will nurture their students’ success.

Tracking the second derivative of student performance: For most students in the Bridge program, the question is not whether they will encounter difficulties, but when. We have learned that identifying these difficulties early, and intervening quickly and positively, is essential to bolstering success in the critical core graduate courses that form an essential component of student retention. We cannot afford to wait until student performance drops below some threshold, at which point intervention is difficult and less likely to succeed. Rather, we constantly monitor student performance and intervene as soon as we detect an inflection in trajectory. For example, we track the courses that Bridge students enroll in as part of the advising process, and then actively monitor their progress by asking their instructors to promptly notify us at the first signs of concern. One-on-one tutoring is provided, as needed, by advanced graduate students or postdocs, and course-load adjustments are made mid-stream if it is determined that remedial instruction is required before re-enrolling in the course.

4. OUTCOMES

Since its inception in 2004, the Fisk-Vanderbilt Master's-to-PhD Bridge program has attracted a total of 34 students, 31 of them underrepresented minorities. Of these, 92% have either already transitioned to the Vanderbilt PhD program, to another PhD program of their choice, or are making satisfactory progress toward that goal. The Fisk-Vanderbilt Bridge program is on track to award 10 times the U.S. institutional average number of minority PhD recipients in astronomy. Our most recent incoming cohort alone includes more minority students than the current annual production of minority PhD astronomers for the entire U.S.

In addition, our students have been awarded the nation's top graduate research fellowships from NSF (GRF and IGERT) and from NASA. Moreover, and critical to the support of the research based mentoring relationships that are so central to the program, extramural grants received to support the bridge program—support for graduate students, faculty, and related undergraduate research—now exceed \$25M, including NSF CAREER awards to the program's lead faculty.

We believe these initial outcomes reinforce the efficacy of our approach and suggest that the program may well serve as a model for other programs built on active partnerships with minority-serving institutions.

The program's key design considerations can be summarized as follows:

- Focus on retention. Direct programmatic efforts toward fostering one-on-one mentoring relationships between students and potential PhD advisers, through enrollment in core PhD courses and through research assistantships in PhD faculty labs. When faculty know a student personally, and can vouch for their performance in coursework, and in the laboratory, they can effectively and persuasively advocate for the student based on a holistic evaluation of the student's ability.
- Focus on recruitment, not competition. Direct recruitment efforts on truly broadening participation by emphasizing potential instead of already proven ability. Be willing to take risks in admissions, and then erect scaffolds of support to ensure success. Competing with other selective institutions for the few highly sought applicants who stand out in traditional metrics does little to address the needs of the national STEM workforce.
- Involve key decision-makers in programmatic design and oversight. Faculty who lead graduate admissions must be active stakeholders in the process of matriculating, supporting, and monitoring students. Deans who oversee academic units must commit to work with—and place accountability on—programs that fail to retain students.

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Recent Hiring Trends at Goddard's Sciences and Exploration Division

Nick White, NASA/GSFC Sciences and Exploration Director, Women in Astronomy and Space III, 2009. Presented at the Inn and Conference Center, University of Maryland, University College, October 21, 2001

Thank you and a heartfelt thank you to the organizing committee of this conference. Anne Kinney came to me, I think almost two years ago now, with the idea of having a third meeting about women in astronomy. It was about the time I began my job as the director of science at Goddard and it was perfect. It fit in very nicely with what was happening at the time and I know it has been a huge amount of work and I really thank you all.

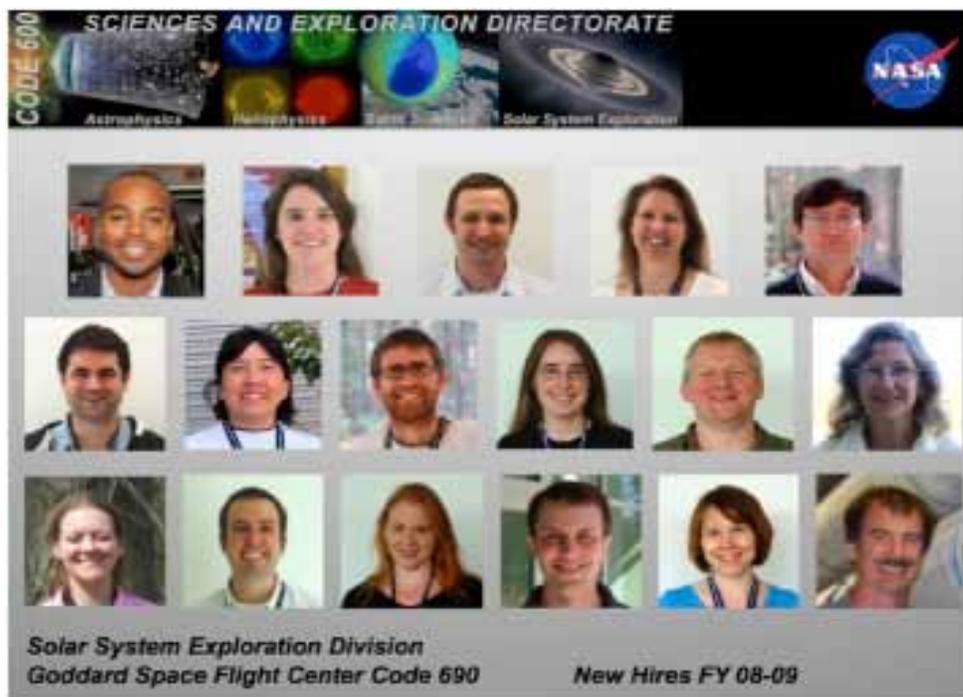
I lead a very large organization. We have about 550 civil servants of which 350 are scientists. On top of that we have a large university and contractor workforce. In total it's around 1200 people in my organization. But the number one priority of my job is hiring new people into the workforce, and I think it is the most important part because it has a long-term impact in terms of what happens at the center and at NASA. We had been in a hiring lull for a long time.

We had only been doing the hiring on an emergency basis. We had people retiring and we were not doing one-for-one replacement. So, I came into a situation where the average age of the workforce was something like 58 or 59. There was a huge bulge in the age distribution and you could see that as this bulge was continuing to grow, we would be in a very problematic situation. One of my highest priorities was to get hiring. So we went for it. I wanted to be really sure that we took diversity into account as part of that hiring process and to make sure that we were not just going to the usual suspects but expanding our scope to do broad searches.

I gave my four division directors in Earth, Heliophysics, Astrophysics, and Solar System Exploration clear understanding that I was looking for diversity in the workforce hiring. I wanted to make sure that when they hired they had the best applicants coming in and were the most diverse pool of applicants possible.

Over the last 18 months we have done a lot of hiring. We have brought in 58 new scientists across my entire directorate. Of those hires, 34% were women scientists. As we continue to hire, I am sure we will proceed in the right direction and increase this percentage.

A concern I have is in minorities and underrepresented groups. They are also being brought into our workforce. About 7% of the new hires are African American—two women and two men. We have a problem: the pool is not big enough in the underrepresented groups. And so my second priority is making sure the pipelines of people coming into the work force are there for us to hire from. We have a number of new initiatives to try to increase the pipeline of people coming through, and I hope to learn some things at this meeting to help with that effort.



The above photo is from Anne Kinney's division, the Solar System Exploration Division; Anne had been extremely enthusiastic about hiring a diverse team. Just look at the faces. I don't want to go through the names but it just gives you an idea of the diversity that we are aiming for at Goddard. Not just male, female, but also in ethnicity, and age-distribution. We have some excellent new people at the center.



The above photo shows the other two divisions in Space Science: the top part is Astrophysics and the bottom part is Heliophysics. Unfortunately the photo does not show all the new hires. For the fiscal years of 2008-09 there were not many new hires in Astrophysics. We are waiting for a decadal survey that is going on at the moment that will tell us the future direction of Astrophysics and the future of big missions we will be handling. So we had to hold back on hiring in Astrophysics except for near term needs for which we have already had funding commitments. By this time next year when the decadal survey comes out there will be a mini-surge of hiring in Astrophysics.

We must consider not only the pipeline for new hires but also the environment that we provide for our scientists at the Center. I am very sensitive to the environment around this center—to make sure that we are not inadvertently hindering the progress of creating a diverse workforce. New hires must all be given the opportunity to excel at their jobs, so we must be on the guard against subconscious bias that may hinder certain groups of people. I find the topics of this conference's upcoming talks extremely interesting and I will be looking for inputs as to how we can better address these issues.

V. GENDER IMBALANCE, DIVERSITY,
AND LGBT ISSUES

Physics and Astronomy at the University of Western Ontario: A Case Study in Building a Gender-Balanced Department

Sarah C. Gallagher, The University of Western Ontario (UWO); **Carol Jones**, UWO; **Els Peeters**, UWO and The SETI Institute; **John de Bruyn**, UWO

SUMMARY

The University of Western Ontario (UWO) has one of the largest fractions of women faculty (nine out of 30, or 30%) in a Department of Physics and Astronomy of any research university in North America. For the astronomers in this department, the numbers are even higher at 45% (5/11). This recent development is largely the result of high turnover from retirements, targets of opportunity, and the university policy of partner hires. Additionally, generous family-leave policies (available to both men and women) and its location make UWO appealing for junior faculty with school-age children. Maintaining this gender balance will depend on establishing long-term strategies for transitioning current fixed-term faculty to permanent positions.

DEPARTMENT RENEWAL

Within the past decade in Canadian universities, the generation of faculty originally hired to meet the demand of baby boomers entering post-secondary education retired in large numbers. In conjunction with a healthy economy, this led to a wave of junior faculty hires in all departments. Since January 1999, the Department of Physics and Astronomy has hired more than two-thirds (21 out of 30) of its current faculty members. This includes all of the 11 astronomers in the department, less than half of who currently have tenure. With 27 graduate students (including 15 women), the astronomy group is a large and active force within the Department of Physics and Astronomy, making up 36% of both the faculty and graduate student populations. The demographics of the whole department and the astronomy group alone are shown in Figure 1.

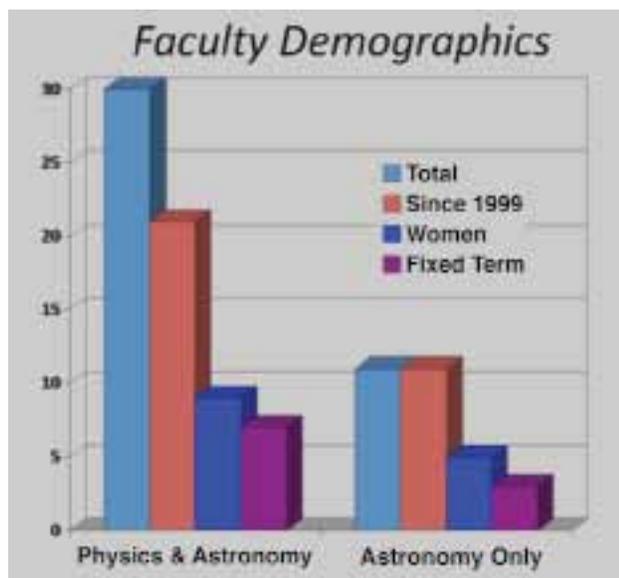


Figure 1. A bar chart illustrating the demographic distribution of faculty in Department of Physics and Astronomy as a whole (left) and the astronomy group (right). The large fraction of recent hires and women are evident in both.

BUILDING THE DEPARTMENT

Targets of Opportunity

Three of the women in the department were hired in conjunction with two federally funded programs to attract outstanding talent. After a fixed term, the university commits to fully funding faculty that is initially supported, in part, by the Canadian government. One program, the Tier 1 Canada Research Chairs (CRC), is “for outstanding researchers acknowledged by their peers as world leaders in their fields.” The second program, the University Faculty Award (UFA), was specifically targeted to fostering talented female and/or aboriginal scientists and engineers. Both CRC and UFA positions allow time (with a reduced teaching load) and resources (with some guaranteed research funds) to enable faculty members to enhance their impact in their fields. Unfortunately, the UFA program has been discontinued.

Partner Hires

The astronomy group has grown by two as a result of partner hires. According to department practice, partners (including unmarried and same-sex couples) are typically hired into 50%/40%/10% teaching/research/service positions (compared with 40%/40%/20% for standard tenure-track faculty) with a three or five-year fixed term that is renewable at the discretion of the Chair. The funding for such positions is divided in thirds with the university and the departments of each partner contributing equally. Fixed-term hires can supervise graduate students and apply for grants, and it is not apparent from department web pages or job titles which of the junior faculty have fixed-term appointments. While this has enabled an increase in total numbers and the numbers of women in the astronomy group (one of whom is a partner hire and one of whom had a partner hired), the situation is tenuous without a mechanism for converting these positions into permanent ones.

Family Policies

With support from the province of Ontario, maternity and paternity leave are covered at 95% of salary for up to a year combined for both parents; both men and women take advantage of this policy. High-quality daycare is available on campus for university affiliates, and subsidies are available for students. The province of Ontario has made support for early childhood a priority; this includes public preschool starting at age four, and Early Years Centers which host free breast-feeding clinics and parenting classes. Combined with an affordable housing market and a healthy school system, the city of London—located approximately midway between Toronto and Detroit—is appealing for individuals with school-age children.

MAINTAINING THE BALANCE

Of the current Physics and Astronomy core faculty, seven are in fixed term positions with three or five-year contracts. These members make up 33% and 50% of the department's female and visible minority cohorts, respectively. At present, while there is a desire at the department level to convert at least some of these positions to permanent status, there is no clear path forward at the Faculty of Science level, particularly in the current economic climate. An additional problem for long-term retention of new hires is the common difficulty that non-university partners have in obtaining work in London. While the city is the 15th largest in Canada and has a diverse economy, a large fraction of the population was born and raised locally. Newcomers to southwestern Ontario frequently have difficulties "breaking in" to this community. Ensuring the hard-earned gender balance is maintained in Physics and Astronomy will require continued attention to these issues.

In summary, the Department of Physics and Astronomy at UWO has become a leader in hiring quality individuals without gender bias. In order to maintain this unique position, steps must be taken to provide the support needed to retain the balance that has been achieved.

The authors thank Amanda Moehring for helpful discussions and comments.

Transitional States: Addressing the Gender Imbalance Among Postdoctoral Researchers at UC Berkeley

Jennifer L. Hoffman, University of Denver; **Maryam Modjaz**, UC Berkeley; **Andrew A. West**, Boston University; **James R. Graham**, UC Berkeley

SUMMARY

The postdoctoral period represents an important transition in the careers of astronomers who complete an average of two postdoctoral terms before taking a permanent position. This transition can be particularly fraught for women, as it can correspond to a lack of stability in income, geographic location, health insurance, and future prospects at a time when many are thinking of starting families or attempting to solve the two-body problem. Any analysis of how to make the field more inclusive needs to address the role the postdoctoral transition may play in influencing young scientists' career decisions.

We present results from a study investigating gender ratios among the postdoctoral researchers (“postdocs”) in the UC Berkeley Astronomy Department over 12 years. We found a statistically significant dearth of female postdocs in recent years compared with peer institutions and national PhD production rates. These results prompted a series of meetings between faculty and postdocs to discuss ways to address this gender gap. We discuss the suggested policy changes that arose from these meetings. We hope this case study will spark a dialogue regarding best practices that will help create positive postdoctoral experiences not only for women, but for all early-career astronomers.

1. INTRODUCTION

Because the postdoctoral years present many obstacles for women in the typical astronomy career “pipeline,” making the field more diverse will require considering the postdoctoral experience as a factor in young scientists' career decisions. We began to examine the climate for postdocs in the UC Berkeley (UCB) Astronomy Department by comparing gender statistics for this population with those for the PhD pool, for peer institutions, and for the field at large.

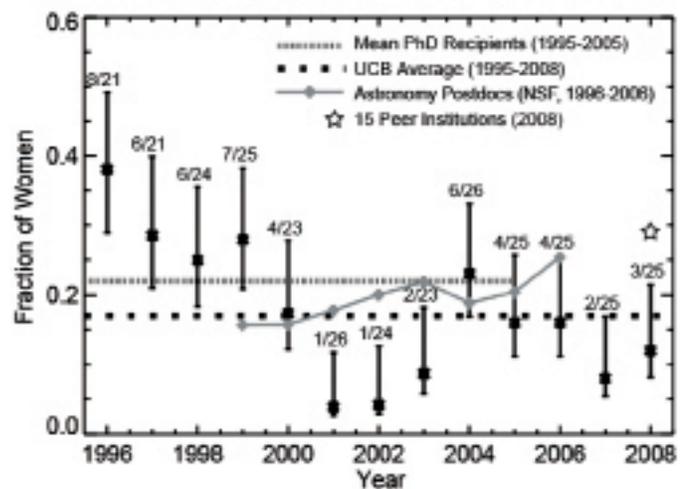


Figure 1. Percentage of women among postdocs in the UC Berkeley astronomy department (black points and fractions) compared with other statistics described in § 2.1.

2. GENDER RATIOS AMONG ASTRONOMY POSTDOCS AT UC BERKELEY

As affiliates of UCB Astronomy, two of us (MM and AAW) noticed an apparent dearth of women among postdocs in our department and investigated the statistical significance of this effect. With the support of current (JRG) and former department chairs, we obtained office-seating records from 1996 to 2008 and used this information to calculate the percentage of female postdocs in the department over time (see Figure 1). Our intention for this study was not to portray UCB as a place where issues of diversity are ignored, but rather to examine an institution where the number of women postdocs is low, and to discuss potential solutions to make the postdoctoral population more diverse in this and other departments.

2.1. Data and comparisons

We found that over 12 years, the average percentage of women among UCB astronomy postdocs was $17\% \pm 2\%$. In recent years the numbers have been lower: from 2000 to 2008 the average percentage of women among postdocs was $11\% \pm 2\%$. (Error bars were calculated from binomial statistics and represent random deviations from the computed fractions.)

To put these statistics into context, we obtained several other datasets for comparison. From the 2005 Survey of Earned Doctorates (Hoffer et al. 2006), we found that the average nationwide percentage of women among PhD recipients in astronomy from 1995 to 2005 was 22%. Astronomers receiving PhDs during this time period formed the pool of available postdoctoral applicants for the years covered by the UCB data. We also investigated the fraction of women among astronomy postdocs in the field at large (NSF 2007). These data show that from 1999 to 2006, women made up between 15.5% and 22.5% of the postdoctoral researchers in astronomy, with an average of 19%.

Institution	Women	Total	Percent
Caltech	11	54	20.4%
Carnegie	7	15	46.7%
ESO	5	12	41.7%
Harvard	18	54	33.3%
IAS	3	14	21.4%
LBL	2	15	13.3%
Princeton	7	19	36.8%
SAO	9	27	33.3%
U. Arizona	6	18	33.3%
UCLA	4	15	26.7%
UC Santa Cruz	4	22	18.2%
U. Hawaii	5	26	19.2%
U. Texas	3	14	21.4%
U. Virginia	2	7	28.6%
U. Washington	5	10	50.0%
UW-Madison	3	13	23.1%

Table 1. Number of female postdocs, total number of postdocs, and percentage of women among postdocs at 15 astronomical institutions in 2008.

“Snapshot” surveys conducted by the AAS CSWA place the fraction at 20% in 1999 and 21.6% in 2003 (Hoffman & Urry 2004; not shown in Figure 1). Finally, we re-researched the current (as of 2008) percentage of women among astronomy postdocs at 15 top-tier departments comparable in quality and prestige to UCB’s. Table 1 lists these institutions and presents the data for each, obtained from their online directories. A simple average shows that women made up 29% of the postdocs in astronomy at these peer institutions in 2008.

2.2. Analysis and trends

Figure 1 shows that the twelve-year average percentage of women among UCB astronomy postdocs falls significantly below the percentage of women among astronomy PhD recipients. In addition, from 2000 to 2008, the average UCB percentage dropped to 3σ below the twelve-year average and 5.5σ below the PhD rate. In only two of these eight years was the fraction of female postdocs at UCB consistent (within uncertainties) with the field-wide average. In 2008, the fraction of women among postdocs at UCB was significantly lower than the average fraction at fifteen peer institutions, most of which (Table 1) had comparable total numbers of postdocs.

We also investigated the change in the UCB results when prize fellows (recipients of national Chandra, Hubble, Jansky, NSF, and Spitzer Fellowships and the UCB Miller Fellowship) were excluded. The average fraction of women among non-prize postdocs at UCB from 2000 to 2008 was $9\% \pm 2\%$, 1σ lower than with prize fellows included. During this time period, Hubble Fellows were 30% women and NSF Fellows were 62% women (STScI 2009; Norman et al. 2009). Departmental information revealed that in 2008, women made up 27% of the prize fellowship applicants proposing UCB as their host institution (10/37; JRG, priv. comm.). Thus, the percentage of women among postdocs hired directly by the UCB astronomy department was especially low during this time, and this low ratio was not due to a lack of qualified female candidates.

3. STRATEGIES FOR INCREASING DIVERSITY

Two of us initiated (MM and AAW) and led (MM) a series of discussions with faculty and postdocs in the UCB Astronomy Department focused on the issue of postdoctoral diversity (see NAS 2000; NRC 2006). As a result of these discussions, the department now encourages PIs seeking postdocs to advertise in the AAS Job Register and the AAS-WOMEN newsletter instead of relying on word of mouth; to include diversity statements in postdoc ads; and to inform potential hires about spousal opportunities, child care, and other work-life balance resources at UCB. The department has also considered implementing a cluster-hiring model for select positions by combining advertisements

for multiple postdoctoral opportunities and forming a committee to judge applications. In related efforts to improve the postdoctoral climate at UCB, the department has obtained PI status on grants for prize postdoctoral fellows; initiated women's lunches and networking events with female colloquium speakers; and begun an effort to have an administrator (not a postdoc or faculty member) keep accurate statistics on the makeup of applicant pools, offers, and hires for postdoctoral positions.

We hope these best practices will foster greater diversity among postdocs at UCB and lead to a better understanding of the issues affecting the postdoctoral climate in this department and across the field. To help astronomical institutions assess their postdoctoral programs, nationwide statistics are also needed; these could perhaps be collected in conjunction with a decadal demographic survey.

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LGBT Workplace Issues for Astronomers

Laura Kay, Barnard College, NY, Dept. of Physics and Astronomy, Dept. of Women's Studies;
With contributions from the GLBTQastro discussion group

SUMMARY

While state and federal laws offer protection against discrimination on the basis of sex, there are no federal laws to protect lesbian women from discrimination on the basis of sexual orientation or gender expression. Sexual minority astronomers (lesbian, gay, bisexual and transgender; LGBT) can face additional challenges at school and work.

1. THE ISSUES

A. LGBT students on many campuses report experiences of harassment, including acts of intolerance, fear for their physical safety, and concealment of their sexual orientation/gender identity to avoid intimidation (Rankin 2003).

- i. Undergraduate students are the most likely to have experienced harassment; both faculty and students say they have concealed to avoid discrimination. Many LGBT people feel pressure to 'cover' (Yoshino 2006).
- ii. Lack of visible LGBT mentors affects students, postdocs, and junior faculty especially.
- iii. Multiple issues for multiple minorities.

B. Federal Equal Employment Opportunity laws and regulations do not provide protection for LGBT people.

- i. Cities, counties, and states may or may not have statutes to protect against discrimination based on sexual orientation or gender identity or gender expression.
- ii. There is wide variation in how states and insurance plans handle legal and medical issues for transgender people ("Tenured Radical" 2009).

C. U.S. Federal law does not acknowledge same-sex partners.

- i. The Federal Government does not consider people with legal same-sex marriages from other countries or from U. S. states family.
- ii. Government employees cannot get benefits for partners, including health care, insurance, and pension benefits.
- iii. Even people whose institutions offer some domestic partner benefits are not eligible for the federal Family Medical Leave Act, cannot sponsor their partner for immigration, must pay additional taxes on the healthcare benefits etc.

- iv. State DOMA (defense of marriage act) laws have been used to remove existing domestic partner benefits at some institutions. Or benefits can disappear with a change in governor (AZ).

Astronomers who change schools/institutions may experience significant differences in their legal and marital status (Nelson, 2008).

2. A STUDY

A recent study interviewed a small sample of ten lesbian and four gay faculty members in science and engineering departments at arts and sciences, engineering, and medical schools within two research universities (Bilimoria and Stewart, 2009).

- A. Some interviewees say colleagues expressed or revealed their discomfort about minority sexualities in a variety of ways;**
- B. some noted they realized how difficult it is for LGBT graduate students to deal with so many “clueless faculty” (p 90);**
- C. they had a sense of isolation, and concerns about consequences for one’s career**
- D. the authors ask if the heterosexual faculty colleagues and administrative leaders in academic science and engineering departments are more uncomfortable than those in other departments—perhaps because the straight faculty aren’t interested in colleagues’ identities and personal lives or because they are less informed about sexual orientation issues;**
- E. more studies are needed with larger samples and a non–STEM comparison group.**

3. SOME PROGRESS

A. In Industry:

- i. Over half of the Fortune 500 companies offer domestic partner benefits, 95% include sexual orientation in their EEO policy, and ~40% include gender identity.
- ii. Some companies are working to move beyond the issues of benefits, to include recruitment, a gay supportive workplace climate, training about gender transition, and supporting pro-gay legislation (Davidson 2009).

B. In the Federal Government: Nondiscrimination statements and more tolerance on security clearance issues (Messenger, 2009).

C. In Academia:

- i. In a self-reported database, over 550 colleges offer protection against discrimination, including 96 which include gender identity or expression, and 309 provide healthcare benefits to same-sex domestic partners.
- ii. Other institutions have non-discrimination clauses in admissions and housing, and offer benefits such as gym and library cards, reduced tuition for partners, inclusive family leave policies, and partner health insurance. (Winfeld 2005)
- iii. Successful strategies include researching options, collecting data from other similar institutions, and advocating for a “plus one” policy that can include an elderly parent, unemployed sibling, or domestic partner.
- iv. Organizers at the Univ. of Alabama, Birmingham made a short documentary video interviewing faculty and staff about the need for domestic partner benefits (Delisle, 2009). They won; benefits are scheduled to begin in Jan 2010, but there is legislative dissent.
- v. More LGBT scientists are out and writing about their issues in science journals (Kurzweil 2008; Mukergee 1995, see also transgendered Stanford neurobiologist Barres’ 2004 paper on Gender and Science and his earlier experiences as Barbara compared to how he is treated now as Ben).

4. WHAT CAN YOU DO

- A. Ask if Your Department is a safe space for LGBT people.**
- B. When recruiting, be prepared to answer questions about workplace climate, domestic partner benefits, etc. Familiarize yourself with your institution’s LGBT webpage, (if there is one). Know who to send applicants to for additional answers.**
- C. If you are losing prospective or current students or employees over LGBT issues (especially if they take fellowship or grant money with them!), notify top administrators.**
- D. Educate yourself about the effects of city, state, and federal DOMA laws on your institution (and support efforts to have these laws overturned).**
- E. If this topic makes you uncomfortable, ask yourself why. It wasn’t all that long ago when it was acceptable for a male scientist to say he was “personally uncomfortable” working with women, or that allowing women at Observatories would be “too complicated” or that maternity leave would be “unfair”. Diversity and tolerance in the workplace benefits everyone.**

ACKNOWLEDGMENTS

Thanks to the members of the GLBTQastro discussion group for suggestions for this poster.

Hats off to gay rights pioneer Franklin Kameny, (WWII vet & Harvard Astronomy PhD) who was fired in 1957 from his job as an astronomer in the Army Map Service for being gay. He took his federal lawsuit as far as the Supreme Court, picketed the White House, co-founded the Mattachine Society of Washington, and challenged the “sloppy sleazy science” behind psychiatry’s assumption of the psychopathology of homosexuality—all in the 1960s. He received a formal apology on behalf of the US government in June 2009 (Wikipedia 2009).

Let us also acknowledge Denice Denton, who spoke in 2002 at the AAS/CSWA meeting in Seattle and in 2003 at the *Women in Astronomy* meeting in Pasadena, on her work to develop programs to enhance equal opportunity for women in science and engineering. Denice became the first openly gay person to serve as a Chancellor in the UC system in 2005. Her death in 2006 led to much discussion about homophobia in academia, the media, and society (Kapp, 2007).

ASTRONOMY RESOURCES:

Outlist Webpage: <http://www.physics.ucsb.edu/~blaes/lgbtastro/>

Yahoo group: GLBTQastro@yahoo.com

AAS meeting GLBTQ dinners: usually Monday night, check the bulletin boards. A blog: The Astrodyke: <http://astrodyke.blogspot.com/>

National Organization of Gay and Lesbian Scientists and Technical Professionals. <http://www.noglstp.org/>

New group for physicists: <http://groups.google.com/group/lgbtphysicists/>

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Tough Talk: Women Giving Colloquia

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(1) NOAO, (2) University of Arizona, (3) Steward Obs., (4) Spitzer Science Center, (5) Boston Univ., (6) Columbia Univ., (7) Univ. of Illinois, (8) UCSD, (9) Cornell, (10) Univ. of Washington, (11) Univ. of North Carolina, Chapel Hill, (12) Univ. of Denver, (13) UCLA, (14) Indiana Univ., (15) Caltech/NRAO, (16) Dept. of Terrestrial Magnetism, (17) Lowell Obs., (18) Gemini Obs.

SUMMARY

We surveyed 46 universities and astronomy research institutions regarding the gender makeup of their colloquia. We find that the average percentage of women giving colloquia at these institutions ranges from about 10-33%. We also look for trends in the colloquia percentages with university demographics and the workforce status of female colloquia speakers. We examine how representative colloquia are of the female astronomical workforce.

1. INTRODUCTION

Attending and giving talks are essential parts of career development for astronomers. Invitations to speak at conferences and give colloquia are important career milestones. Colloquia, in particular, continue to be an important means of exposure for early career scientists providing an opportunity to increase the visibility of one's research and to make oneself known to the broader astronomical community.

We present archival data collected from 46 universities and other research institutions on the gender makeup of their colloquia from 2004-2008. Given the prestige and career advancement potential of giving colloquia, we examine how representative the colloquia are by comparing these data to the general availability of women in the astronomical workforce.

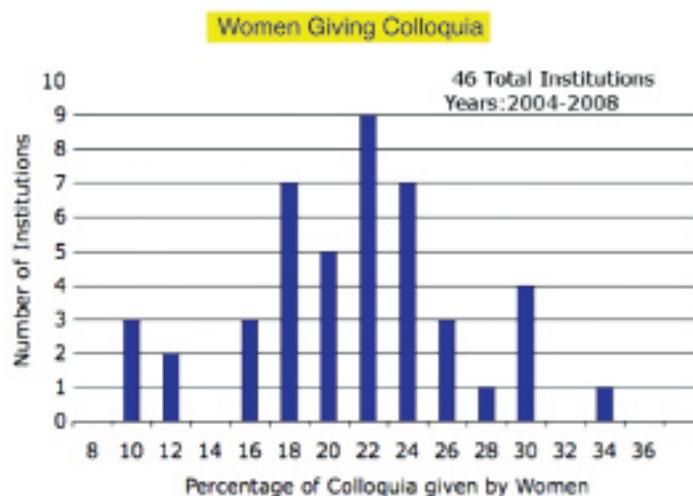


Figure 1

2. COLLOQUIA AT 46 ASTRO RESEARCH INSTITUTIONS

The histogram in Figure 1 above shows the percentage of colloquia given by women for the 46 institutions surveyed. The percentage is averaged over multiple years. For most institutions we were able to include the full five-year span. The average percentage of colloquia given by women is 21%. In Figure 2 below, we see that as the number of women receiving PhDs in astronomy and astrophysics (squares) grows, so does the percentage of colloquia being given by women (stars). For the most recent two years (2008, 2007) of our survey the fraction of colloquia given by women tracks well the

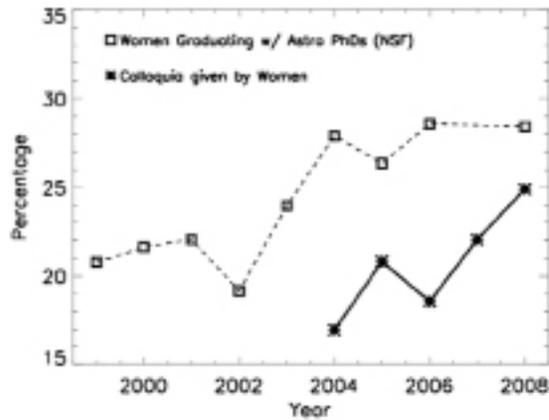


Figure 2

percentage of women graduating with PhDs in astronomy and astrophysics five years earlier (2002,2001). We compare these years because after five years these women have had the time to become faculty or more senior postdocs who make up the vast majority of female speakers (shown in the pie chart below).

Status of Women Colloquia Speakers

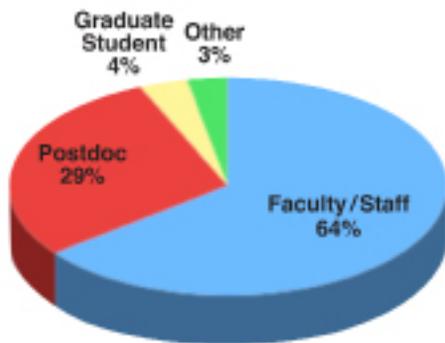


Figure 3

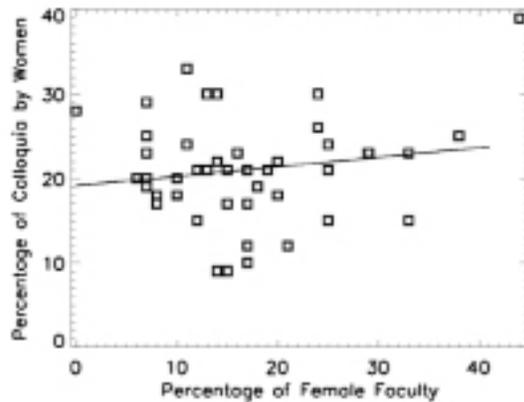


Figure 4

3. DEPARTMENT DEMOGRAPHICS VS. COLLOQUIA CONTENT

We find that there is little or no correlation between the percentages of women giving colloquia with the “ladder” female makeup of the faculty at an institution (shown

in Figure 4, above). We take “ladder” faculty/staff to be those with tenure track or long-colloquia are by comparing these data to the general availability of women in the astronomical workforce.

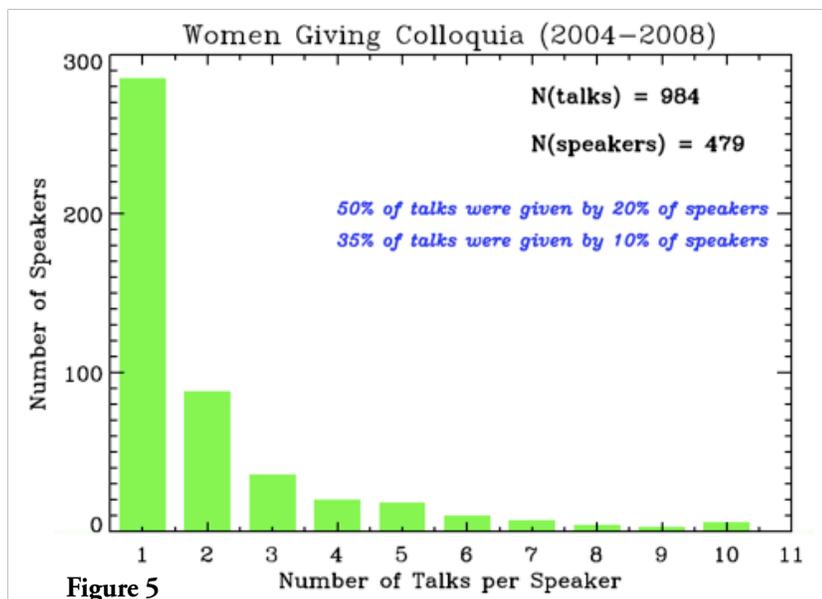


Figure 5

4. ARE COLLOQUIA REPRESENTATIVE OF THE POOL OF WOMEN IN ASTRONOMY?

One of our goals is to investigate how representative colloquia are of the pool of women researchers. In Figure 5, we look at the numbers of women who were invited to give multiple talks over the full five years. Roughly half (505/984) of the speakers gave more than one talk during this time. Note that one speaker gave 17 colloquia. Although this point is not shown on this figure, it has been included in the relevant calculations. We also find that about 50% of the talks given by women were given by about 20% of the women who gave talks during this period.

In Figure 6, we compare the percentage of colloquia given by “multi-speaking” women in each year (triangles), to the percentage

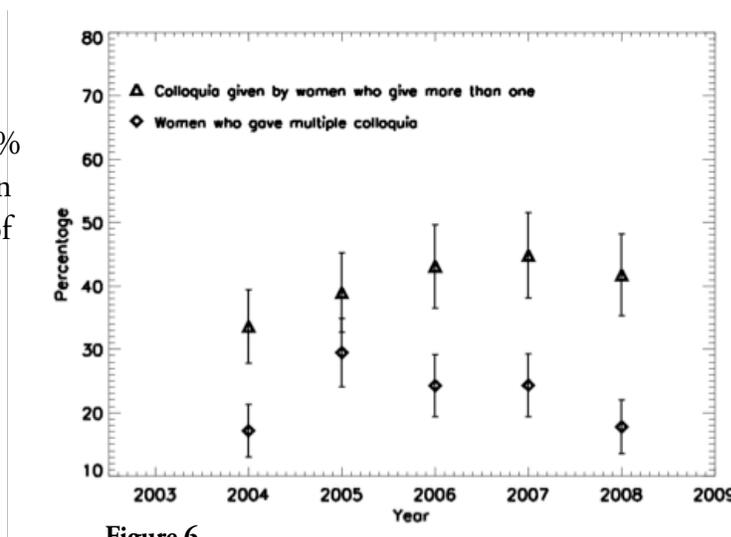


Figure 6

of women who gave those colloquia (diamonds). The errors are Poisson. We find that while the percentage of colloquia is trending upwards, the percentage of women giving those talks is staying flat or may even be trending downwards. This suggests that fewer unique women are giving colloquia talks in any given year.

5. CONCLUSIONS

- 1) On average, women give less than a quarter of the colloquia. This compares to the 17% (AIP, 2007) overall percentage of women astronomy faculty (of any rank) in 2006; the mid-range year surveyed, and 20.8% (NSF, 2007); the percentage of women awarded PhDs in astronomy and astrophysics in 1999, five years prior to 2004.
- 2) The percentage of colloquia given by women is growing.
- 3) The majority of colloquia given by women are given by faculty/staff members.
- 4) There is no correlation of the percentage of colloquia given by women in an institution with the percentage of “laddered” female faculty at the institution.
- 5) From 2004 to 2008, half of the colloquia given by women were given by about 20% of the women giving talks.
- 6) The percentage of colloquia given each year by women who give more than one is increasing while the percentage of women who give multiple talks is flat or decreasing. Thus, representation of women in colloquia series is becoming more restricted to a “core” group of women. This suggests that although the number of women giving colloquia is increasing, colloquia are not necessarily becoming more representative of the female Astronomy and Astrophysics workforce pool.

List Of The 46 Astronomy/Astrophysics Colloquia Surveyed:

Univ of Arizona/NOAO	UC, Irvine	Texas A&M
Arizona State U	UC, Los Angeles	Univ of Washington Univ of Wisconsin
UC, Berkeley	Univ of Maryland	Yale
Boston U.	Univ of Massachusetts	
Caltech	MIT	U British Columbia
Univ of Chicago	Univ of Michigan	Montreal
Columbia U.	Michigan State	U Toronto
U. Colorado, Boulder	Univ of Minnesota	U Victoria
Cornell	Univ of NC, Chapel Hill	
UC Davis	Univ of Pennsylvania	Carnegie Obs.
Univ of Denver	Penn State Univ	CTIO/Gemini
Univ of Florida	Princeton U	Dept Terr. Magnetism
Harvard/CfA	Rutgers U.	Lowell
Univ of Hawaii	UC, San Diego	STScI
Univ of Illinois, Urbana	UC, Santa Cruz	Spitzer Sci Center
Indiana Univ	Stanford	
	Univ of Texas, Austin	

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Data collection for this project was done with Google Docs.

Diversifying the Next Generation of Astronomers; One Institution at a Time

Antonella Nota, Space Telescope Science Institute/European Space Agency; **Sheryl Bruff**, STScI; Bernice Durand, Univ. Wisconsin–Madison; **Kathy Flanagan**, STScI; **Matt Mountain**, TScI; **Meg Urry**, Yale

SUMMARY

The limited representation of women and especially minorities in astronomy is of serious concern. This issue needs to be aggressively and immediately addressed in order to avoid a negative impact on the future scientific and technological leadership of the country. We believe that the only way to radically change the *status quo* is to set some ambitious goals of increasing the percentage representation of women and minorities in the astronomical workforce by a factor of two for women, and by a factor of five for minorities, over the next ten years. We advocate for a plan that involves universities, as well as centers, national laboratories and funding agencies, working together to design and implement a coordinated strategy to achieve this goal.

BACKGROUND

It is well established that the key to success for any institution, whether its goals are profit, increased productivity or academic achievement [1,2] is to attract and retain a diverse workforce. People of different gender and ethnic background contribute different perspectives and approaches. This variety creates an environment that is inclusive, receptive, and tolerant, and that stimulates creative thinking and innovation. These factors are key to institutional achievement and success. The projection is that in a few decades, the population in the US will not be predominantly white. Hence, a plan to diversify the workforce today is essential to effectively exploit the intellectual resources of the nation in the future and to maintain scientific and technological leadership.

THE CURRENT SITUATION IN SCIENCE: US ASTRONOMY IS WHITE AND PREDOMINANTLY MALE

The US population has an increasingly diverse profile. It is currently approximately split in half according to gender. African American and Hispanic individuals account for 12.8% and 15.1% of the population, respectively (Table 1).

	Total	Female	African American	Hispanic
US Population (2007)	301.601.157	152.962.259	38.756.452	45.504.311
		50.7%	12.8%	15.1%
Space Telescope Science Institute Staff	366	145	21	5
		40%	5.7%	1.3%
# PhDs in Physical Sciences (2006)*	1993	578	48	79
		29%	2%	4%
STScI Astronomers	72	9	0	0
		13%	0%	0%

Table 1. Demographic data for the US Population [3], the Physical Sciences workforce [4,5], and a typical astronomical institution, STScI. *Note: These data reflect the nature of current data available, which include Physics, Astronomy and Chemistry.

A typical American scientific institution often does not reflect that profile. For example, the Space Telescope Science Institute (STScI) by nature of its mission must employ staff with a very diverse skill mix, including research staff as well as engineers, technical support personnel and administrators. Traditionally, STScI had a staff predominantly composed of white males. The situation was even more extreme when considering the astronomer research staff, where the number of female astronomers fell into the single digits, and African-American and Hispanic astronomers are still completely absent. STScI is making a concerted effort to improve the demographics mix of its staff and some success has already been achieved. However, these numbers are far from atypical when one considers the small numbers of PhDs awarded in 2006 to women and minorities in Physical Sciences, which includes Astronomy, Physics and Chemistry (Table 1). Advancement in Astronomy in the future, as for all sciences, will require a broader participation of diverse populations to ensure continued discovery, innovative solutions to unique and novel problems as well as adequate representation of the evolving composition and nature of the American population.

AGGRESSIVE HIRING IS ONLY A PART OF THE SOLUTION

In an ideal economic situation, where scientific hiring can be carried out aggressively, some improvement in representation can be achieved on a relatively short time scale. Even in a tight economy, institutions must make improved representation in hiring a priority. This requires that recruitment best practices be successfully implemented. For example proactive recruitment of targeted groups and bias-aware selection; that attention be paid to the organizational requirements of a diverse employee base; and that policies facilitate the retention of the individuals targeted and successfully hired [6].

It is also critical for the institution to develop a climate that welcomes a diverse staff, where tolerance and inclusion are set as a strategic goal, and a priority, at the highest institutional levels.

As an interesting case study, STScI was successful in increasing the number of female astronomers from 3% of the research staff in 2005, to the current improved fraction of 13%. The number of female astronomer departures has reached an all-time low in the last three years and was reduced to zero in 2009 due to a dedicated and collective effort to create a more open and hospitable work environment. This included addressing tolerance and cultural issues, as well as implementing a suite of family friendly policies. Still, there is more that can be done.

REPRESENTATION OF WOMEN IN ASTRONOMY: THERE IS NATIONAL-SCALE PROGRESS

The number of PhDs in astronomy awarded to women has dramatically increased over the years. As reported by the American Institute of Physics [4], 30% of the total number of astronomy PhDs were awarded to women in 2006, compared to less than 10% in 1977.

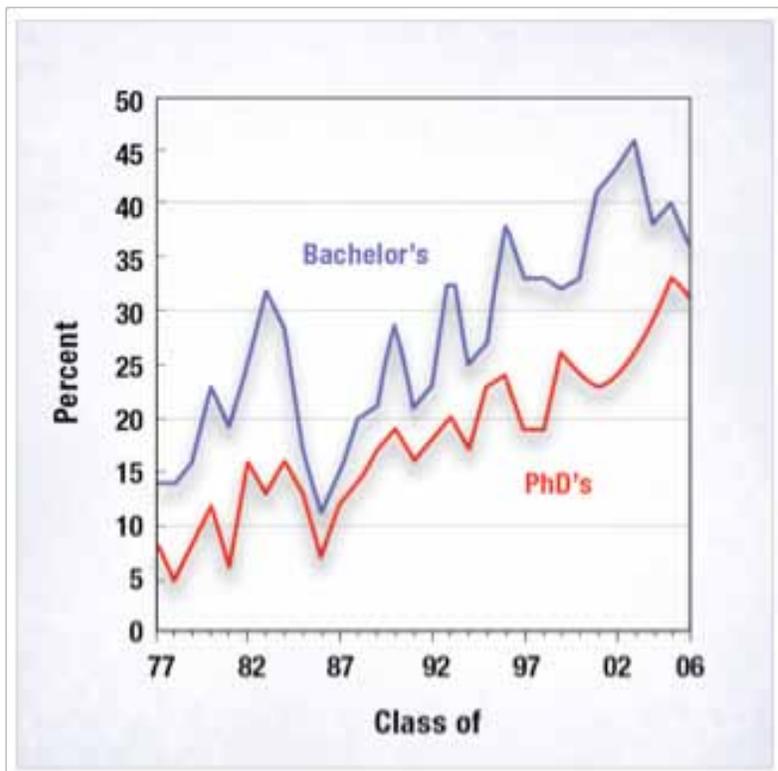


Figure 1. Percentage of Bachelor's Degrees and PhDs in Astronomy awarded to women from 1977 to 2006.

The percentage of Bachelor's Degrees awarded to women is higher, hovering around 40% in 2002-06. This indication that significant losses of women still occur during the graduate years is of concern.

The marginal success in astronomy has not been realized to the same extent in physics. Although some growth has been observed over the years, only 15% of physics PhDs awarded in 2006 were to women. For women scientists, the challenge remains in advancement through academic career ranks.

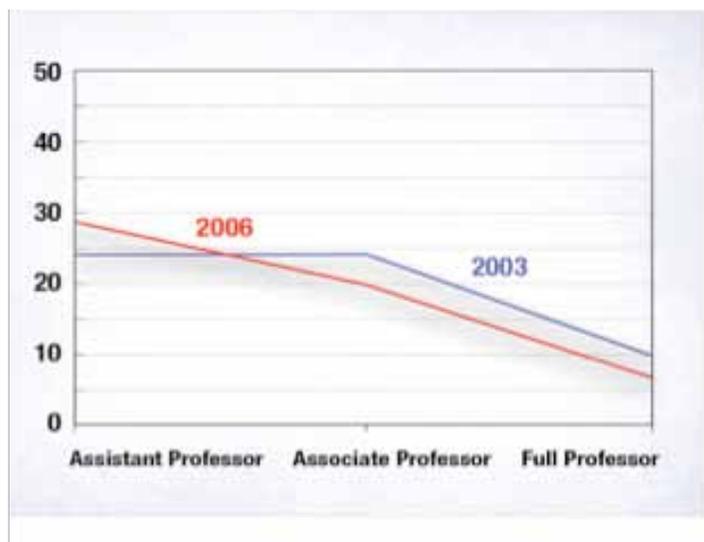


Figure 2. Percentage of female astronomers as a function of rank in 2003-2006.

In Figure 2, the percentage of female astronomers is plotted as a function of rank. Although the numbers have been increasing in recent years at the entry level (assistant), drops are still recorded in promotion to associate; and a significant drop (>50%) is observed in promotion to full astronomer, where women ultimately make up only 10% of the total. This number has not changed in recent years, and is an indication that a glass ceiling for women in academia is still alive and well.

MINORITY REPRESENTATION IN ASTRONOMY: AGGRESSIVE HIRING IS ONLY A SMALL PART OF THE SOLUTION

The current situation for minority astronomers is worse than what was observed for women in the 1970's. This is clearly exemplified by the difficulty finding reliable data tracking the progress in education for minority astronomers. Major funding agencies such as the National Science Foundation (NSF) [5] have only very recently started to track comprehensive and detailed demographic data on minorities. As can be seen in Figure 3, adapted from Stassun [8], the percentage of Astronomy PhDs awarded to

African-American and Hispanic astronomers remain in the low single digits. It is encouraging that the number has roughly doubled in the last five years, demonstrating the tangible national-scale results of dedicated initiatives, such as the Fisk-Vanderbilt Bridge Program.

However, from the point of view of an institution such as STScI, where we have established diversity in the workforce as a high priority objective, these numbers are not sufficient to enable us to meet our goal. Even in a situation where every single minority astronomer is hired, the representation numbers are too low to make a difference on a global scale; and they do not reflect, by far, the composition of the US population.

We are not attempting to outline, discuss or interpret the complex causes for this limited representation. The fact is that in order to make a difference in representation, it is necessary to create a much larger pool of minority astronomers.

THE GOALS OVER THE NEXT TEN YEARS

It is necessary to set the ambitious goals that the representation of women and minorities in professional astronomy must increase in percentage by a factor of two for women, and by a factor of five for minorities over the next ten years.

This major goal can only be accomplished if universities, centers, national laboratories, and funding agencies work together to develop a coordinated plan that addresses different facets of the issue as a part of a unified strategy. The plan has two natural components: 1) The creation of the diverse workforce. This area of strategic emphasis targets issues associated with undergraduate enrollment in astronomy (as well as physics and other STEM disciplines) programs through the attainment of a PhD. 2) The employment and career advancement of the diverse workforce. This area of emphasis targets the period from the attainment of a PhD through the individual's transition to the workforce, and commitment to a career in astronomy.

PHASE 1: The creation of a diverse workforce. Universities must take the lead in this phase.

Universities should encourage active enrollment of women and minorities, especially for STEM disciplines. Understand and confront pipeline issues. Set realistic, but ambitious, university-wide goals at each milestone in the education process, from undergraduate to graduate—especially for minority students, small losses have great impact on the outcome, given the extremely low numbers in play. Create programs that

supplement the sometimes-limited scientific education that some minority students may have experienced in their previous curricula. Design and implement strategies to level the educational playing field. Set the goal to enable minority students to become as competitive as white students who may have benefited from greater education opportunities and resources throughout their scholastic careers.

PHASE 2: The employment and the career advancement of the diverse workforce. Centers, observatories and national laboratories must lead the way in this phase.

When recruitment is possible, recruit in a proactive and targeted fashion, by reaching out to special groups. Post position notices broadly with specific attention to utilizing sources well-integrated in target communities. Compose the search committee with the strategic goals of enhancing diversity in mind. Selection bias should be discussed and addressed. Address possible two-body issues proactively and constructively. Take deliberate steps to create a hospitable and tolerant work environment. Cultural and behavioral issues should be addressed with high priority, to create a respectful environment, where every single individual feels appreciated for his or her contribution to the institution. Inclusion should be the preferred and reinforced style for conducting work interactions. Implement family-friendly policies to alleviate some of the demands of family life. Implement mentoring programs to ensure that the newly recruited scientists experience a successful transition to the workplace, and the foundations are set for a fruitful career. Ensure clarity on the requirements for major career milestones (such as tenure) and ensure that career review processes are fair and transparent. Set some realistic but ambitious goals to advance female and minority astronomers to the highest career steps as expeditiously as their white male colleagues.

Funding agencies have oversight of both phases. They have the ability to hold universities accountable for their ability to generate a diverse workforce. They can create incentives for universities, centers, observatories, and national laboratories to be successful at creating, recruiting and advancing a diverse workforce. They can fund programs dedicated to address specific issues, such as the competitiveness of minority students at undergraduate and graduate enrollment level.

No one group can solve this issue on its own. Only a coordinated and collaborative effort among all STEM fields will enable the type of significant change on a national scale required to respond to the needs of the astronomical community of the future.

FINAL REMARKS

We will have achieved success—in equalizing opportunities in education, minimizing bias in hiring and promotion, and creating fair and equal workplaces—only when women and minorities are represented in the workforce in proportion to their representation in the general population. Action must be taken now if we hope to achieve any significant change over the next ten years, and implement President Barack Obama’s vision, “to give (ALL) our children the chance to live out their dreams in a world that’s never been more competitive,” and to continue leadership in science and technology in the future.

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The 30% Benchmark: Women in Astronomy Postdocs at US Institutions

Joan Schmelz, University of Memphis; **Nancy Brickhouse**, CfA; **Dara Norman**, NOAO; **Jim Ulvestad**, NRAO; **Sheryl Bruff**, STScI; **Neil Barker**, Gemini Observatory

SUMMARY

When Post-doc applications are evaluated by individual scientists (or telescope support groups) rather than prize fellowship committees, will the gender-related data show equivalent success rates for women? We analyzed data from CfA, NRAO, NOAO, STScI, and Gemini Observatory and compared it to the gender-related data gathered for the Astro2010 committee. We find that for these institutions, there is no significant difference between the success rate of women in prize fellowships and individual post-docs: each is about 30%. Since the fraction of astronomy PhDs going to women has been between 25% and 30% in recent years, these numbers indicate that the Post-doc selection process, on average, introduces no additional gender-related bias. This result serves as a benchmark for progress in equitable hiring.

INTRODUCTION

The gender-related data from the upcoming Astro 2010 demographics report shows that, for almost 20 years, approximately 30% of the prize postdoctoral fellowships in astronomy have gone to women. The figure below (courtesy of Naveen Reddy) shows the number of astronomy prize postdoctoral fellowships from 1990 – 2009 along with numbers and fractions of fellowships awarded to persons from non-US PhD institutions and to females. The total number of fellowships represented here is 450 and includes the Hubble, Spitzer, Chandra, Fermi, Einstein, NRAO, and Jansky fellowships. The data come from:

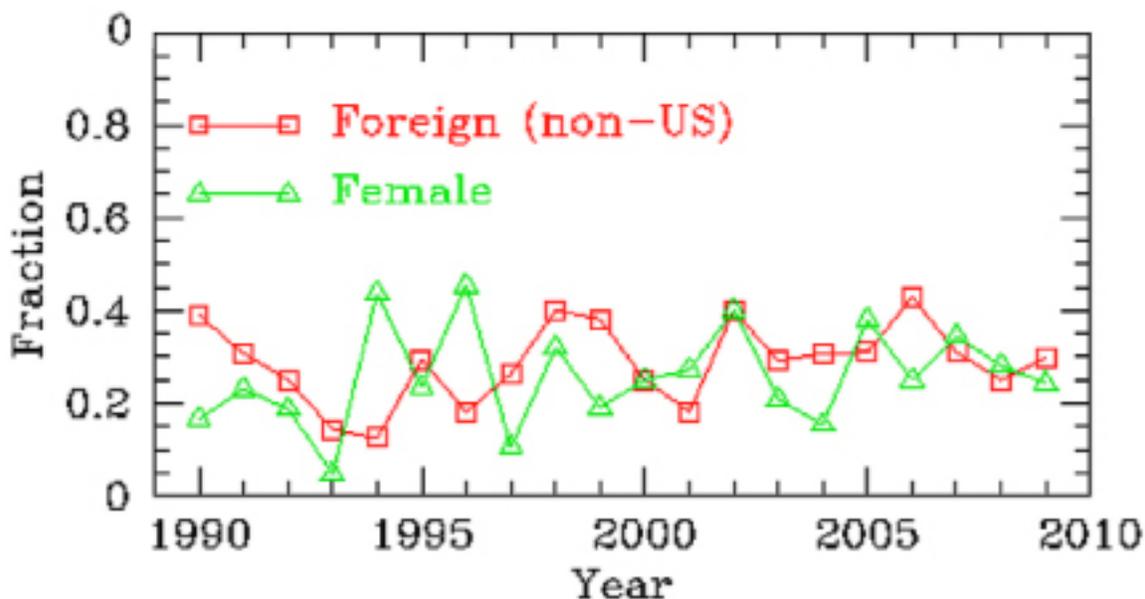
<http://www.stsci.edu/institute/org/spd/hubble-fellowship/fellows-list>;

<http://ssc.spitzer.caltech.edu/geninfo/fellows/fellowslist.html>;

<http://cxc.harvard.edu/fellows/fellowslist.html>;

<http://www.nrao.edu/admin/dol/pastpostdocs.shtml>.

In most cases, these individuals were chosen by a committee whose members would more than likely remind each other that gender balance was an important factor in the selection process. We were wondering what happened when postdoc applications are evaluated by individual scientists (or telescope support groups) rather than prize fellowship committees. Would women have a similar success rate?



DATA

We analyzed data from CfA, NRAO, NOAO, STSci, and Gemini Observatory.

Gemini Science Fellow hiring over the past 10 years:
20M; 10F or 33%F. Hiring takes place by selection committee.

NRAO stats from 1997 through 2008:
Jansky: 33M; 11F or 25%F; Non-Jansky: 14M; 6F or 30%F

STSci stats since Feb 1999:
55M; 29F or 34.5%F

CfA stats from 2006 and 2007:
Named: 21M; 7F or 25%F; Individual: 72M; 34F or 32%F

NOAO stats from 2004 through 2009:
Named: 5M; 4F or 44%F; Individual: 14M; 8F or 36%F

We find that for these institutions, there is no significant difference between the success rate of women in prize fellowships and individual Post-docs: each is about 30%. This result serves as a benchmark for progress in equitable hiring. Since the fraction of astronomy PhDs going to women has been between 25% and 30% in recent years, these numbers indicate that the Post-doc selection process, on average, introduces no additional gender-related bias.

CONCLUSION

Graduate enrollment in US astronomy departments has risen from 25% in 1997 to 30% in 2006 (NSF-NIH Survey of Grad Students and Post-docs in S&E).

The percentage of Astronomy PhDs earned by women in the US has increased steadily from <20% in 1997 to almost 30% in 2006 (NSF Survey of Earned doctorates).

The percentage of women faculty at stand-alone astronomy departments in 2006 was 28% (assistant professors), 24 % (associate professors), and only 11% (full professors).

The good news: the graduate student–Postdoc joint of the leaky pipeline does not appear to be leaking!

The not so good news: the faculty pipeline continues to leak.

Benchmark: If the percentage of women Pos-docs at your institution is significantly lower than 30%, then there may be a problem.

Thanks to the members of the Astro2010 Demographics study group for helping to point us toward useful statistical information.

The Mysterious Disappearance of Women: The Origin of the Leaking Pipe—Cumulative Bias Gender Equity in the First EURYI Scheme*

Darach Watson, Anja C. Andersen and Jens Hjorth, Dark Cosmology Centre, Niels Bohr Institute, University of Copenhagen

ABSTRACT: An analysis of the first European Young Investigator Awards, precursors to the European Research Council's flagship Starting Independent Researcher Grant programme, shows that female applicants were only half as likely to succeed compared to the average. The reason for this lack of success appears to be related to the nature of the assessment, which involved three successive rounds. A small effect, preferentially removing female applicants in each round, led to an overall cumulative bias of a factor of two. The nature of this attrition is reminiscent of the leaking-pipe effect seen in women's careers in science, and suggests that the leaking-pipe is independent of time, i.e. time-related factors are not the driving cause, but that the reason behind the leaking-pipe may instead be very straightforward: a series of low-level (~10–20%) biased thresholds applied at each career stage. Such a bias would be very difficult to detect without large number statistics, but would lead to a large cumulative effect. If this hypothesis is correct, it indicates that the leaking-pipe problem may be very simple, and have a correspondingly simple solution.

The first European Young Investigator (EURYI) awards were announced in July 2004, providing twenty five young scientists with up to €1.25 million to establish research teams in Europe. The international nature of the awards and the large number of applicants (777) makes the EURYI competition a contemporary benchmark of the fairness of unmodified peer-review, an assessment method still ubiquitous in the disbursement of research funds. The EURYI scheme was discontinued with the establishment of the European Research Council (ERC) in 2007 and was essentially a pilot programme for the ERC's flagship Starting Independent Researcher Grant programme.

Though the EURYI awards were created by the European Heads of Research Councils and the European Science Foundation (ESF), the management and the assessment process are supported by the European Commission (EC). Comments and directives concerning women in science by the European Parliament, the Council of Ministers and by the Commission¹ suggest that the sex disaggregated statistics should show the fruits of best practice for fairness and equity. But on obtaining these statistics from the ESF, the first year's awards were worrying. Only three² of the twenty five awards offered initially were to women, far below the percentage working in science at the targeted career

* N.B. This expanded and updated article first appeared as a letter in the July 2005 issue of *Nature* magazine.

stage and a straightforward analysis indicates discrimination between the applications of men and women. While nearly a quarter of initial applicants were female, only an eighth of the awards went to women. Simply, men applying for an award were more than twice as likely to succeed. The consistent attrition of the female fraction at each stage of the competition and the size of the sample, means that we know it cannot have occurred by fluke, the random chance probability is only 0.05%. We also know that the small fraction of female recipients had little to do with an under-representation of women IN THE INITIAL APPLICATION.

THE SELECTIONS

EURYI applications were submitted to the relevant national research councils that could each then nominate a specific number of candidates. This first selection cut the fraction of women from one quarter to one fifth.

Each national research council oversaw a drop in the number of selected women. An extreme example is Spain, which has a high fraction of women in science at this career stage (~40%) and therefore had a good fraction (>30%) of female applicants, as we might expect. The Spanish research council then proceeded to nominate exclusively male scientists to its 13 allocated places. But the astonishing outcome of this selection was that nominees from Spain succeeded above the average, emerging with the highest ratio of accepted to submitted candidates in the European selection rounds, with nearly three times the average success rate.

From the national nominees (133), European evaluation committees created a shortlist of 67 candidates, causing the largest drop in the fraction of women: $9.9 \pm 0.5\%$ of men applying made the European shortlist, only $4.7 \pm 1.4\%$ of women did. From this shortlist, the fraction remained fairly constant with 12% of the awards being offered to women.

It is often suggested that a significant number of women on the evaluation committees can reduce gender-bias in the selections. In this case, one third of the European evaluation panel members and one third of the panel chairs were women. The results presented here seem to support previous findings that having a significant number of female evaluators does not necessarily boost the success rates of women (ref 5 and references therein).

THE LEAKING PIPE

The analogy between the well-known 'leaking pipe' phenomenon where a disproportionate number of women leave the sciences at each career stage and the steady attri-

tion observed here at each EURYI step (Fig. 1) is notable. It may imply that biased thresholds were applied at each evaluation.^{3,4} While the thresholds are not very striking individually, being of the order of 10% or so, the cumulative effect is large, ultimately halving the percentage of female candidates. The overall effect is larger than observed in other awards and may be related to the multi-step selection process used for the EURYI scheme.

The leaking pipe effect for women's careers in science is often attributed to a complex array of external factors that cause women to drop out of science before, during or after obtaining a doctorate, or prior to achieving a permanent position. However, the same effect is clearly discernible here and cannot be attributed to these factors. For the EURYI awards, the pipe was leaking because the selection process was putting holes in it.

We seem to be observing here a series of sex-biased filters applied to the same set of candidates at the same career stage resulting in a 'leaking pipe'-type effect. It seems likely that a significant part of the observed career leaking pipe may also be simply due to a small, but important, selection committee bias—after all, discrimination against women in scientific peer-review has been well-documented.^{5,6} It is possible that the leaking pipe is not as complex as believed, but may be that our job selections suffer from consistent biases at a level that is hard to assess in small numbers, but that have such a noticeable cumulative effect.

CAUSES

Other academic science competitions (e.g. the Medical Research Council in the UK or the Wellcome Trust)⁷ do not always show gender bias in their statistics. Furthermore, a report by the American Institute of Physics⁸ shows that though the representation of women is low and only slowly improving, the leaking pipe effect does not appear to exist after PhD level in university physics and astronomy departments across the US. These facts imply that a higher success rate for men is not a law of nature, but is very likely due to a selection bias that still can exist frequently in unmoderated peer-review processes.

Among possible causes that need to be examined is the representation of different disciplines in the final awards. Roughly 40% of the awards were in physics or physics-related engineering, which has one of the lowest female fractions of any scientific community, ~15% at this stage (none of these were in astronomy or astrophysics which has a female representation ~25% at the same point). But it is obvious that even with a large overpopulation of the awards with disciplines traditionally poor in women, one cannot arrive at a final fraction of ~12%, which is below the fraction of women at this

career stage in any major scientific discipline in Europe.⁹

To replicate the ground-breaking analysis of Wenerås & Wold⁵ at a European level would be a useful step forward, but the ESF was unwilling to release the data that would have enabled such a study. Without a detailed knowledge of candidates' applications and the judging criteria, it is impossible to nail down the precise cause, but as noted above, the fairly equitable success levels observed in other schemes and in recent AIP statistics and the well-documented biases inherent in unmoderated peer-review selections,^{5, 6} suggest that an inherent deficit in the abilities of women to do science or write proposals must be viewed as an unlikely explanation.

SETTING AN EXAMPLE

After signal calls to promote the equality of men and women,¹⁰ it was vexing that a competition organised by major European institutions was so unsuccessful at protecting the percentage of women who applied in the first instance. One is left with the impression that little effort was made. The EURYI awards would not be exceptional in this regard; European national research councils frequently do not pay a lot of attention to the problem. For example, sex disaggregated statistics, the first step in identifying and characterising systematic problems, are frequently not published or made available.¹¹

An encouraging sign is that after initial questioning on the sex disaggregated statistics, the call for the 2005 EURYI awards urged, '[y]oung talented women ... to apply as they were under represented in the applications in the first call.' Though the expression can only help, the statement is misleading, as we have shown above, since lack of applications was not the primary reason women were under-represented in the final awards. Another positive indication was that the ESF commissioned a study¹² of the first year's selection however it signally failed to uncover the inequity we note here.

In the context of gender equity in the EURYI awards the ESF statement goes on to quote a delightfully tongue in cheek response from an awardee in the first call: 'I have received several grants. Sometimes I had the feeling that it was because I was a woman... This time I know I received the award because of my qualities!' The irony of the remark seems to be lost on the ESF. It is obvious that she certainly deserved the award—the question is whether many others who also deserved were unfairly excluded.

We published a short report on this analysis in *Nature*¹³, before the subsequent EURYI round, and it is gratifying to note that the assessment procedures in the second EURYI awards were made to be more equality aware. Correspondingly, those grants were somewhat more equitably distributed, with 20% of the grants going to women from an applicant pool of 24%.¹⁴

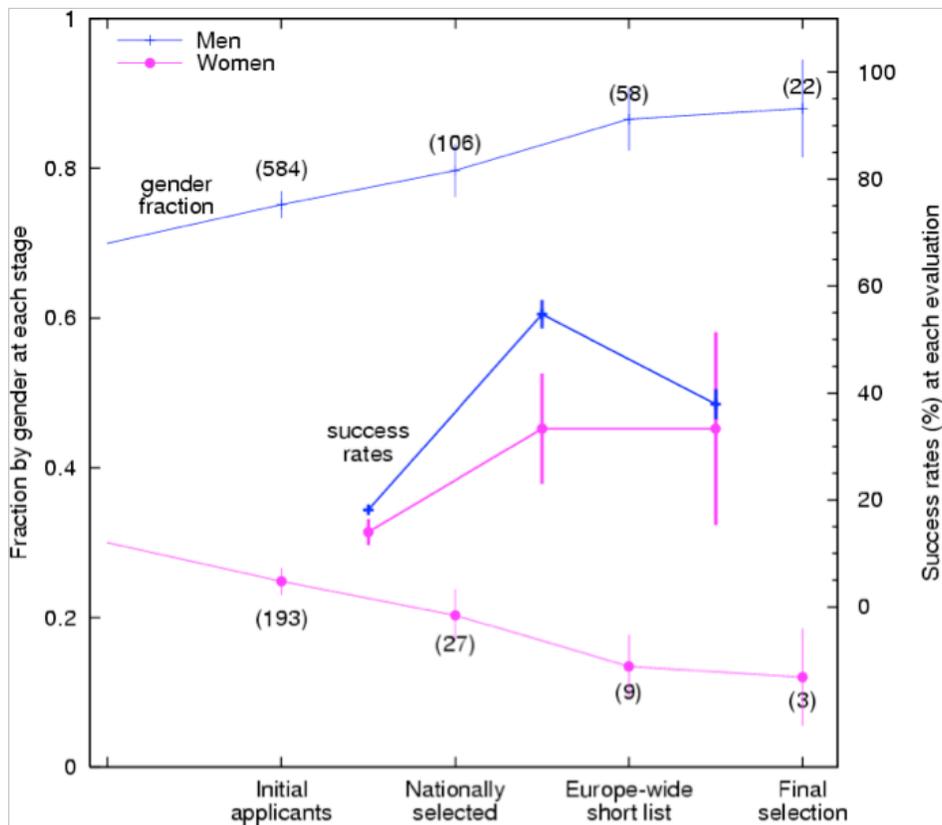


Figure 1. The fraction of men and women remaining at each stage of the selection process for the EURYI awards. The diagram is reminiscent of the scissors plots used to illustrate the falling fraction of women as a function of career advancement in the sciences. The similarity may indicate that the problems associated with career advancement in the sciences for women may also be due simply to the selection mechanisms used for promotion and tenure. The right axis shows the rate at which men and women succeeded in progressing to the next stage of the competition. Men were clearly more likely to succeed at each step of the evaluation procedure.

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VI. CAREER CHOICES AND
WORK-LIFE BALANCE

Setting the Treadmill

Kelly E. Fast, NASA/GSFC¹

INTRODUCTION

On my mark, get set, GO! Wait a minute...why didn't I think about the rest of my life when I chose my major??? We are faced with choices when it comes to balancing family and work responsibilities. Research fields in particular are demanding of time and riddled with deadlines. Pressure on all fronts can make it difficult to be honest

with ourselves and set the priorities that suit our own situations, and so we struggle to keep from being thrown off the treadmills of our own creation. Are you happy with your own treadmill run? I've tried my best to find the right treadmill settings for me and my family...and I'm still trying! Here is a



“ARE YOU THE NEW SECRETARY?”

I was not offended. Why should I be? No one likes a person who is just waiting to be offended. Besides, I would have thought exactly the same thing! I was so used to working around men that, when I showed up for a summer position at the Los Alamos National Laboratory, it did not strike me at all as odd that such a question would be asked. That was quite a while ago...and the landscape has changed quite a bit in the science community!

“IF I WAS NOT SET UP TO WORK FROM HOME, I WOULD BE ON MATERNITY LEAVE AND YOU WOULD BE STUCK!”

I had the opportunity to telecommute before telecommuting was common. It was an option that kept me from quitting altogether at the time. It also added its own pressure...like getting phone calls about Jupiter data analysis only a few days after

¹Also chauffeur, lacrosse mom, wife, cook, field trip chaperone...

giving birth! The lines between work and home blurred. It was great to be able to launch a radiative transfer analysis of a high-resolution spectrum and then step into the kitchen and stir whatever was on the stove. It was also easy to deceive myself into thinking that I was spending time with my family when my mind really was elsewhere. Laptops and high-speed connections have given us even more flexibility, but they can also tempt us to work all day on site as well as all evening at home if we are not careful. The challenge is finding the balance that is advantageous to both our families and colleagues...without wearing ourselves out!

“I AM GETTING WAY TOO OLD FOR THIS!”

There was a gap between my M.S. and Ph.D. and at one point, with dirty dishes in the sink and two kids at home, I found myself back in school. And, I found myself sitting at the dining room table doing my homework—next to my daughter—who was doing her own homework. OK, I know you are never too old to go back to school, but really!

“MOMMY, WHEN YOU GRADUATE, WILL YOU SPEND MORE TIME WITH US?”

OUCH!!! I thought I had done a pretty decent job with the treadmill settings before my daughter asked that question, but WOW that hurt. Kids will take everything you have to give. However, keep in mind that your colleagues are big kids—they will also take everything you have to give! Be content in your own mind that you are giving sufficiently to each. Neither will ever be fully satisfied, but you should be!

“I DON’T LIKE TO TRAVEL FOR WORK. I WANT TO SPEND TIME WITH MY FAMILY.”

OUCH, OUCH!!! I felt like my husband was twisting the knife when he said that! Don’t get me wrong, he is super supportive of me, but he does not travel much for his job and he likes it that way. Although he loves to travel, he would much rather travel with our family. I, on the other hand, do not like to travel, but I do like the mom-break that an observing run gives me. But a work trip can easily turn into a guilt trip. Should I feel guilty that lack of oxygen, lack of sleep, long hours, and potentially dangerous conditions are an absolute vacation for me? OK, we all have our own preferences when it comes to recreation (especially scientists), but moms (and dads) DO need to take breaks. At least that’s what my fellow moms have assured me of.

“MOM! PLEEEEEEZ! DON’T SHOW HOTEL MAUNA KEA!”

So I made a goofy YouTube music video with my colleagues that was well received by ground-based astronomers. When my son heard that I might use it in a talk that I was to give to his class at school, he panicked! My son was embarrassed by me. I had therefore fulfilled my role as a parent.

If you are a parent and a scientist, you already have two strikes against you in the “coolness” department. So, take advantage of that fact! Give talks and judge science fairs at your kid’s school (and other schools). Scientists are encouraged to do public outreach, so why not start with your kid’s school? If your schedule is flexible, help out in the classroom or attend field trips. Sometimes there are tasks that can be done after hours that can serve the school. It should not always fall to the other parents; so if at all possible keep that treadmill setting where it will allow participation in your kid’s school. After all, your kids are only young once, the schools are where future scientists will come from, and you too will be able to fulfill your obligation as a parent by embarrassing your kid!

“I WANT TO BE A DENTIST...OR MAYBE AN ASTRONOMER!”

I just about panicked when my daughter said that! “Sweetie, be a dentist. It’s much more practical and you won’t have to beg for money to cover your salary!” Why would I not encourage her to do what I love to do? I’m still trying to figure that out, but more often than not we do the opposite. We tell prospective scientists about exciting advances in the field, newsworthy research, and our own cool projects without being honest about the practical side of research: proposing for funding, travel, publish or perish, conferences, review panels, and being aware that a research career often does not recognize evenings and weekends. Helping prospective scientists to be well informed should not be thought of as discouragement. Rather, it should enable them to have a vision for what that treadmill might be like before they step onto it.

“I’VE FAILED AS A PARENT!”

I say that in jest when my kids do something silly. However, I don’t EVER want to mean it. Everyone has their own situation that they must address and their own choices to make when it comes to setting the speed and incline on the treadmill, both moms and dads. My hope is that you will find the settings on your own treadmill that will work for you!

WHAT IS YOUR WORK/FAMILY TREADMILL LIKE?

These are the results of an unscientific survey of...well, scientists! Poster session participants were invited to check “yes” or “no” to a number of questions on the poster that was the basis for this article. The response totals from the end of day two of the conferences are presented for your own interpretation.

Did you consider how a research career might fit with a potential future family when you chose your major or career path?

YES: 10
NO: 28

Do you feel that accommodating your family compromises you professionally?

YES: 23
NO: 7

Two more indicated both.

Do you feel that accommodating your research career compromises you as a spouse/parent?

YES: 22
NO: 11

Are you satisfied with your balance of research and family?

YES: 16
NO: 15

Two more indicated both.

One jotted the question “What about other jobs/duties?”

I realize now that I should not have limited the question to research.

Are/Were you able to volunteer in any way for your child’s school?

YES: 14
NO: 4

Undergraduate/Graduate Students: Have any professors/advisors/mentors shared with you, either formally or casually, about balancing a research career and a potential future family?

YES: 9
NO: 4

One jotted this note: “No, other than to say, ‘Don’t marry another scientist!’

I didn’t listen!”

Relating Educational Experiences and Career Choices

Alyssa Gilbert, The University of Western Ontario

SUMMARY

How do the educational experiences of women in astronomy or space science influence their career decisions? Results of a recently developed survey are presented, where over 50 women with graduate level education in astronomy or related fields were asked about their undergraduate and graduate educational experiences, reasons for choosing their academic path, relationships with their graduate supervisor(s), social experiences, expectations, and how their career goals have evolved over time. Connections between experiences and career choices will be discussed, and a list of future work will be given.

INTRODUCTION

Many recent studies (see for example, Reid & Matthews, 2007; Mehr & Rees, 2007) show there continues to be a consistent decline in the percentage of women in astronomy or science at each academic level, regardless of the increasing percentage of women in science undergraduate programs (Figure 1).

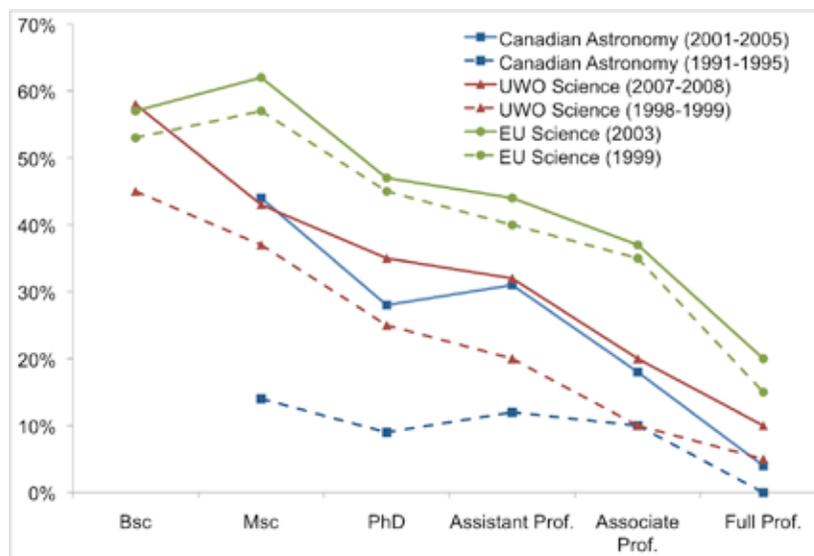


Figure 1. The mean percentage of women in Canadian astronomy (blue; Reid & Matthews, 2007), women in the sciences at The University of Western Ontario (red; UWO data book: <http://www.uwo.ca/ipb/databk08/>), and women in the sciences in the European Union (green; Mehr & Rees, 2007).

There are numerous possible explanations for the causes of the leaky pipeline, (women leaving the sciences at upper academic levels): family demands, low self-confidence, competition, increased responsibility in upper level academic positions, salary, sexism, etc. The study by Martinez et al. (2007) discusses many of these factors and, by surveying more than 1,300 postdoctoral fellows, investigates why women are more likely to quit at this level in their career.

One cause of this attrition rate, as noted in Martinez et al. (2007), may be the undergraduate and graduate educational experiences. To investigate this further, a survey consisting of 25 questions was designed to study how the educational experiences of women in astronomy or related fields affect their career choices.

The survey was broken into three major sections: demographics, undergraduate education, and graduate education. The questions regarding the undergraduate education experience included how and when the decision was made to pursue an undergraduate major; what was the intended career path as they entered university; and how their career path evolved by the end of their degree. The respondents were also asked to rate their satisfaction with their undergraduate institution, department, courses, and social experiences.

The respondents were then asked about their graduate education experiences. They discussed what influenced their decision to continue in academia, their expectations about graduate school, the student-supervisor relationship, and how their career paths evolved. They were also asked to rate their satisfaction with their thesis project, supervisor, department, institution, social experience, and perceived knowledge of their research area.

The survey was given to 51 women enrolled in a graduate program in astronomy or a related field, or had been in the past. Of the 51 surveys, 38 were completed, and the results from only those surveys are used in this study.

DEMOGRAPHICS

The participants were located in Canada (22), United States (8), United Kingdom (3), Germany (2), New Zealand (2), and Finland (1). Five respondents, all in the 30-39 age-range, had at least one child. Figure 2 shows the age range of the respondents, broken down by marital status. All of the respondents had received a Bachelors degree in astronomy, physics or earth science. Of the 38 women who completed the survey, 10 (26%) had a Bachelors degree, 16 (42%) had a Masters degree, and 12 (32%) had a PhD.

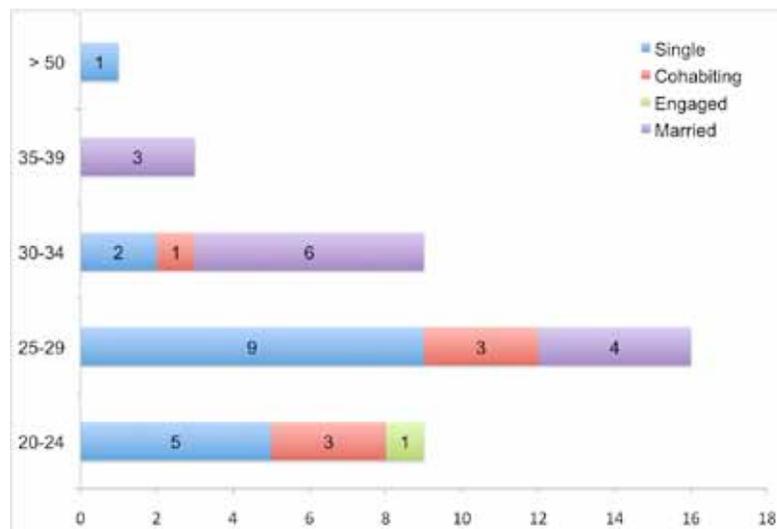


Figure 2. Age range distribution, broken down by marital status.

RESULTS

Of the 38 completed surveys, 18 (47%) women planned to continue in academia. Of those, 8 (44%) rated their graduate education experience worse than their undergraduate experience, and 7 (39%) believed their graduate experiences were different from their expectations in a negative way (more work, more time consuming, more stressful, etc.). All respondents, except one, felt they worked well (67%) or somewhat well (28%) with their graduate supervisor. In this group, 10 (56%) were cohabiting, engaged, or married, 4 had at least one child (22%), and the average age was 30.

The other 20 (53%) women reported they did not plan to continue in academia, were willing to take another career path, or were unsure of their career path. Of those, 16 (80%) rated their graduate education experience worse than their undergraduate experience. In addition, 16 (80%) believed their graduate experiences differed from their expectations in a negative way. Most (18) responded that they worked well (50%) or somewhat well (40%) with their graduate supervisor. In this group, 11 (55%) were cohabiting, engaged, or married, one had at least one child (5%), and the average age was 27.

CONCLUSIONS AND FUTURE WORK

Using these results, there does not seem to be a correlation between marital status and having children in choosing an academic career path. Nor does it seem to rely on the relationship with the graduate supervisor. However, the graduate experience as a whole seems to affect career choices, especially when compared to the undergraduate experience and to initial expectations of graduate school.

In addition, there seems to be a correlation with age, with a greater number of younger women opting out of an academic career. This is consistent with the findings reported in Mason, Goulden & Frasch (2009), who report doctoral students want balanced lives and do not believe this can be provided by an academic career.

It should be noted that there were some biases in this survey:

- Nearly 80% of the respondents resided in North America
- Approximately 65% were in the 20-29 age range
- Most of the respondents were in graduate school or in an academic position in astronomy or related field (although this was not a question on the survey, it was distributed to such communities)

This study is far from complete and the results are considered to be very preliminary. In the future, this study should include responses from a wider range of women, especially those no longer in the field of astronomy. It could be expanded to include questions regarding personal life experiences (i.e., investigating how getting married or having children during graduate school can affect career decisions). It could also be extended to women in other areas of science, and include men to serve as a comparison. Finally, the survey could be markedly improved by partnering with a researcher in the social sciences in order to extract the most relevant information from the survey responses.

ACKNOWLEDGEMENTS

I would like to thank Dr. Carol Jones at The University of Western Ontario for providing data, as well as suggestions and ideas. The participation of the respondents is greatly appreciated.

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How to set up a Lactation Facility

Florence Tan, NASA/GSFC and **Pamela Millar**, NASA/GSFC Compiled by
Diana Khachadourian,ASRC/GSFC from the poster presented at the Women in Astronomy
 and Space Science Conference October 21-23, 2009

A START TO THE RIGHT PATH

The 106th Congress, as part of the fiscal year 2001 budget, passed the Right to Breast-feed language into law. Rep. Carolyn Maloney (D-NY) spearheaded this effort and was able to have it signed into law. The law ensures a woman's right to breastfeed her child on federal property. In June of 2009 the Breastfeeding Promotion Act (HR 2819 and S.1244) was introduced to, "bring breastfeeding mothers under the protection of the 1964 Civil Rights Act, require employers' employees to provide a private space and unpaid time off during the workday for mothers to express milk, and sets standards for breast pump manufacture. It also provides for tax incentives for employers that establish private lactation areas in the workplace with over 50% tax credits for nursing mothers."

As busy new moms and working scientists, the existence of a lactation facility is a welcome addition in the workplace. We will give you a short summary on its importance and how to set one up.

THE BENEFITS OF BREASTFEEDING

For the Baby:

- Breastfed babies are overall healthier and require fewer doctor visits.
- Breastfeeding protects babies against vision defects.
- Breast milk lowers the risk of babies developing asthma, allergies, ear infections, obesity, childhood leukemia, and type one and two diabetes.
- Breast milk contains properties that aid in the development of the baby's immune system.
- Breastfeeding reduces the risk of Sudden Death Syndrome (SIDS).

For the Mom (and Dad):

- Breastfeeding results in fewer workdays missed for the parents because their children are healthier.
- Breastfeeding mothers spend less time and money on doctor's visits.
- Breastfeeding results in more sleep for the parents.

- Breastfeeding reduces the mother's risk of:
 - *Breast, ovarian, and endometrial cancers*
 - *Post partum depression*
 - *Type two diabetes*

Breastfeeding also benefits to our society by:

- Reducing health care costs
- Reducing waste in the environment
- Allowing for more productivity in the workplace because of less days missed

THE SETUP

Setting up a lactation facility in your workplace requires help and management. The steps to setting up lactation facilities in an organization or educational institution are as follows:

The Steps for Winning Management

- Have a volunteer or a departmental coordinator who will see the project of the Lactation Room set-up from start to finish.
- Next, contact your office of Human Capital Management for guidance on how to approach the project. Your organization may even have a website that will give you guidance on the set-up process.
- Speak to your managers and supervisors to get management support.
- Arrange a meeting between the person coordinating the project, management and building supervisor to discuss space for the lactation room(s).
- Above all, have a plan that is clear and ready for the management to approve.

Legal, Health and Safety Issues

- For legal issues make sure that you craft a waiver form for the users of the facility. Consult with your institutions legal department to see what is needed.
- Health and Safety:
 - Provide high reliability, hospital grade pumps. But remember that not all institutions will have the funding to provide pumps.
 - Have a monthly question and answer session with a lactation consultant.
 - Provide training in how to use pumps.
 - Provide guidelines on hygienic pump-use and spill cleanup.
 - Have a hygienic survey and provide custodial services.

The Lactation Room Requirements

The lactation room is a place where a breastfeeding mother can go to express her milk in secure privacy. Not all institutions will have the monies available to create a comprehensive room but an adequate room can be put together without breaking the bank. The room should be located near an accessible building entrance and near a source of water. Ideally the room should have a sink with running hot water but again if funding is not available, a nearby sink will suffice.

- **Space**

Privacy is essential and the room should have a lock from the inside. The size of the room should measure 100 to 150 square feet.

- **Breast Pumps**

If the institution is willing to provide pumps the Medela Classic hospital grade pump is a good recommendation and costs a less than three thousand dollars. Ideally, each room should be equipped with a pump.

- **Supplies**

Sanitary supplies such as Cavicide, Clorox, soap, if there is a sink, a pail, trash can, sponges and paper towels should be available. Other useful accessories are a mirror, magazine rack, clock, and coat rack or hooks. A bulletin board inside, and clipboard attached to the outside of the door can be used for messages and help schedule room use.

- **Furnishings**

The room must have a comfortable chair, preferably with armrests, and a nearby table. The chair should be adjustable to enable each lactating mother to achieve her desired height. A refrigerator is also necessary for the storage of the milk. An under-counter refrigerator will save on space. A telephone should be placed within easy reach of the workspace. The breast pump should be set on a fixed shelf or table.

Select a SuperMom

What is a SuperMom? She is the lactation room manager. The SuperMom may be a present or past user. You may have rotating SuperMoms or choose to delegate this position as you wish. Her duties will be to:

- Maintain sign-in sheet for user metrics
- Arrange for custodial services
- Maintain cleaning and pump supplies in the lactation room
- Provide key or key-card contact for access to lactation room
- Provide user orientation on room and training on pump usage
- Run monthly mom groups with a lactation consultant
- Act as a liaison between users and building FOM and lactation program manager

Lactation Program Management and Evaluation

As in any newly implemented program, to make the lactation facility a success and to improve it, follow these steps:

- Make a quarterly survey of the women in your institution to gauge needs.
- Bring in new lactation rooms per building as needs change.
- Some rooms have no pumps. Make a multi-year plan to upgrade existing lactation rooms with pumps.
- Interface with SuperMoms and interview future and new mothers to understand their needs and issues
- Arrange for lactation consultant mom education visits to each building, monthly, on a rotating basis. Remember that local hospitals are generally supportive of a workplace lactation education program.

Our world is rapidly changing. Double-income families are more or less a norm and many of these families are raising children. The lactation facility is an important improvement to the quality of a young mother's life. Setting up one of these facilities is not as daunting as it may seem. The above recommendations are starts. There are enough resources out there that will enable you to achieve this goal. For example, the web site for the Center for Disease Control has an excellent section on the importance and implementation of setting up such a center. There are also many universities that have already set up lactation facilities that can give you a good introduction to what a facility should be like (i.e. University of Chicago).

Above all and most importantly, talk to those women who have been through motherhood and have never had a chance to use a lactation facility because they were simply not available. These women will give you input and the impetus to forge on and give new young mothers an opportunity that they did not have.

VII. WIA II 2003, CSWA, IYA

International Year of Astronomy 2009 NASA Programs: Diversity Highlights

Hashima Hasan, NASA Headquarters, Washington D.C.; **Denise Smith**, Space Telescope Science Institute, Baltimore; **Mangala Sharma**, Space Telescope Science Institute, Baltimore

SUMMARY

This poster presents some diversity highlights in NASA's International Year of Astronomy 2009 (IYA2009) programs. These include workshops and out-of-school activities developed for girls, as a part of NASA's contribution to the She is an Astronomer global cornerstone project of IYA2009; activities organized by NASA IYA Student Ambassadors, which reach out to underserved and underrepresented communities; exhibit of dramatic astronomical images at non-traditional venues; tactile displays for the visually impaired community and Braille versions of astronomical images; traveling exhibit on how our views of the universe have changed over the past 400 years; and observing programs to encourage all to experience the wonders of the universe.

1. INTRODUCTION

NASA's Science Mission Directorate (SMD) has embraced the opportunity presented by the International Year of Astronomy (IYA) 2009 to take the exciting science generated by NASA missions in astrophysics, planetary science and heliophysics to students, educators and the public worldwide. NASA is an Organizational Associate of the International Astronomical Union (IAU) IYA 2009 program, and as an integral component of national U.S. IYA team, has aligned its activities to the overarching themes outlined by the team. NASA Science Mission Directorate (SMD) celebration of the International Year of Astronomy (IYA) 2009 was kicked off in January 2009 with a sneak preview of a multi-wavelength image of M101, and of other images from NASA space science. Some examples of the progress of NASA programs will be presented. The traveling exhibit of NASA images to public libraries around the country has been a spectacular success and is being extended to include more libraries. NASA IYA Student Ambassadors met at summer workshops in August of 2009 at the Goddard Space Flight Center and presented their projects. NASA's Afterschool Universe has provided IYA training to community-based organizations, while pre-launch teacher workshops associated with the Kepler and WISE missions have been designed to engage educators in the science of these missions. IYA activities have been associated with several missions launched this year. These include the Hubble Servicing Mission 4, Kepler, Herschel/Planck, and

LCROSS. NASA IYA programs have captured the imagination of the public and continue to keep it engaged in the scientific exploration of the universe. NASA's Go Observe! Program provides guidance to the public to observe the object of the month and links to related NASA educational activities. NASA's IYA website astronomy2009.nasa.gov is a key resource to guide visitors to NASA resources and enable participation in special events.

2. NASA PROGRAMS ADDRESSING DIVERSITY

She is An Astronomer: A global cornerstone project of the IYA, the goal of She is an Astronomer programs is to attract and retain girls in the area of astronomy. The following are examples of NASA IYA programs targeted towards achieving this goal: Workshop started community dialog on better engaging girls in astronomy and space science: 30 astronomers and educators discussed resources, strategies and best practices to engage and sustain girls' interest in science during a mini-workshop at the Astronomical Society of the Pacific's 2009 conference (Sharma et al. 2009). Lessons learned from research, out-of-school-time activities in partnership with Girl Scouts, Great Science for Girls, etc., were highlighted. The next step is to build a knowledge-base of resources and research on equitable science education, collaborate and network existing and new programs, and navigate the Education and Public Outreach (E/PO) funding landscape.

- i. *NASA IYA Student Ambassador's focus on underrepresented and underserved communities:* 55 undergraduate and graduate students (>50% women) share NASA science and astronomy with local communities. They reach out to underserved groups in rural areas and small towns in the US. Students serve as peer role models inspiring younger audiences.
- ii. *"After School Universe" targets girls' involvement in astronomy and space science:* This out-of-school-time, hands-on-astronomy series developed by NASA's Goddard Space Flight Center for middle school students targets girls by partnering with organizations such as Girls Scouts, Great Science for Girls, DC Children and Youth Investment Trust Corporation.

From Earth To The Universe (FETTU): NASA participated in the FETTU global cornerstone project by preparing dramatic astronomical images from NASA's Great Observatories, the Hubble Space Telescope, Chandra X-Ray Observatory and Spitzer Space Telescope, and exhibiting them at non-traditional venues, e.g. airports, public parks, shopping malls—where they were seen by millions—including significant populations of women and girls. Tactile displays for the visually impaired community and

Braille version of the Sun, Eta Carinae, Crab Nebula, Whirlpool Galaxy, Kinds of Light panels with materials based on the book, “Touch the Invisible Sky” were also prepared and displayed. The image panels have captions in English and Spanish, thus crossing linguistic barriers and reaching a larger portion of the public.

“Visions of the Universe” Exhibit: A travelling exhibit of astronomical images which tell the story of how our views of the Universe have changed over the past 400 years, reaches underserved communities via libraries. Public libraries provide an opportunity for NASA to reach out to a broad range of audiences; public libraries are used by audiences of all ages and backgrounds, and have strong ties to their local community. During 2009 and 2010, this exhibit, which is distributed in partnership with the American Library Association, will have reached 55 small towns in rural areas as well as large cities.

Observing Programs: NASA’s observing programs are designed to encourage all to experience the wonders of the universe. The NASA IYA web page lists the celestial object of the month, which the public can go and observe for themselves. Accompanying educational material such as “Discovery Guides,” developed in partnership with the Astronomical Society of the Pacific, provide guidance to observers. Other resources include the “Night Sky Network,” which is a nationwide coalition of amateur astronomy clubs that engage schools, Girl Scouts, underserved communities and all the public in astronomy. The “MicroObservatory” project, developed in partnership with the Harvard Smithsonian Astrophysical Observatory, offers facilities with equal access to science through free robotic telescopes that users control over the Internet.

3. NASA IYA SUCCESSES

While it is still early to measure the true reach of NASA’s IYA programs, an informal assessment indicates some broad areas of success.

- The overarching theme “The Universe—Yours to Discover” has provided a focus for education and public outreach efforts.
- Exposure to astronomy has reached broader and diverse audiences across age groups, a variety of cultures and backgrounds, more women and girls, and through non-traditional venues.
- Awareness of astronomical discovery and NASA science in rural and small towns has been raised.
- Targeted science and science education programs for girls and underserved groups have been developed.
- Collaborations with new partners have been created.

CONCLUSION

With an unprecedented number of space science missions operating in 2009, the International Year of Astronomy could not have happened at a more opportune moment for NASA. NASA's missions have equaled the giant leap made in observational astronomy when Galileo turned his telescope towards the sky for the first time. IYA2009 enabled NASA to spread the excitement of astronomy to a wider and more diverse audience than before. NASA IYA programs have increased awareness of astronomy across all walks of life, helped strengthen interest in science and science education, created new partners and enhanced collaboration across and beyond NASA. We plan to keep the momentum going, particularly in the area of education of girls and women, and underserved and underrepresented groups. NASA programs have whetted the appetites of the uninitiated, and kept the dream alive for those already enraptured by the wonders of the sky.

ACKNOWLEDGEMENTS

NASA International Year of Astronomy (IYA) programs have been organized through the Science Mission Directorate, and coordinated by its education and public outreach forums. The NASA IYA programs have been made possible by a large number of community members, professionals and partners, who have used their ingenuity and talent to engage the public. We would like to express our thanks to all these individuals.

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The Pasadena Recommendations: Outcome of WIA II 2003

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SUMMARY

The American Astronomical Society (AAS) established AAS Standing Committee on the Status of Women in Astronomy (CSWA) in 1979. Since the committee's inception, three meetings have been held that have focused on the status of women in astronomy. The first was held in Baltimore, Maryland in 1992. The second was held in 2003 in Pasadena, California. A poster, on the subject of this paper, was presented at the third meeting held in Greenbelt, Maryland. This paper briefly describes the history leading to the 2003 meeting, and then focuses on the meeting itself, and its main outcome, the Pasadena Recommendations.

1. BACKGROUND: STEPS TO THE 2003 WOMEN IN ASTRONOMY CONFERENCE

The first major steps taken by the AAS with regards to women astronomers included creating a working group in 1972, then an ad hoc committee in 1978 [1]. The ad hoc committee was next converted to the standing Committee on the Status of Women in Astronomy (CSWA) in 1979. Its mission was to monitor the status of women in the field of astronomy and recommend changes to improve it.

Twenty years after the establishment of the working group, a seminal conference was held in Baltimore, Maryland on “Women at Work: A Meeting on the Status of Women in Astronomy.” The focus of this conference was the issues that were faced by female astronomers represented by the AAS. At the time that the conference was held, statistical information clearly showed a discrepancy between the available pool of female astronomers and the women attaining positions at nearly every step on the career ladder; this is known as the “leaky pipeline.”

The main outcome of that conference was the “Baltimore Charter for Women in Astronomy.” Using input from the astronomical community, it provided the following guiding principles for establishing gender equity:

- Women and men are equally capable of doing excellent science.
- Diversity contributes to, rather than conflicts with, excellence in science.
- Current recruitment, training, evaluation, and award systems often prevent the equal participation of women.

- Formal and informal mechanisms that are effectively discriminatory are unlikely to change by themselves. Both thought and action are necessary to ensure equal participation for all.
- Increasing the number of women in astronomy will improve the professional environment, and improving the environment will increase the number of women.

The American Astronomical Society endorsed the goals of the Baltimore Charter (although not the Charter itself!) in January 1994 [1]. The Baltimore Charter and the Proceedings from the Baltimore meeting can be found at <http://www.aas.org/cswa/bc.html>.

As a result of the success of the first Women in Astronomy meeting, awareness of issues increased, especially through the publication of the Baltimore Charter. There was an overall decrease in instances of blatant discrimination, and women and men were able to read about and discuss issues affecting the progress of astronomers as they pursued their careers through the CSWA publications STATUS and AASWOMEN. Yet despite some clear victories, statistically for women in astronomy and physics, the situation for career progression in 1999 appeared unchanged from 1992 [2]. Women were lagging behind men at every level in career advancement.

2. THE 2003 WOMEN IN ASTRONOMY CONFERENCE

The apparent continued lag of women behind men mentioned in the previous section led the CSWA to organize a second conference. This conference, entitled “Women in Astronomy II: Ten Years After” was held in 2003 in Pasadena, California. Its purpose was to review the status of women in astronomy, understand their work environment, assess developments since the 1992 Baltimore conference, and recommend future actions that would improve the environment for all astronomers. During the conference, talks covered a variety of topics including: demographics; the “leaky pipeline” and the slower progression of women than men to senior levels; institutional studies and solutions; the importance of diversity; and equity, climate, and the law. In addition, working groups addressed the topics of: (1) family issues: how can the apparent conflict between work and family be eliminated?; (2) business vs. academia: lessons from outside the university; (3) changing the culture on campus: making women welcome and valued; (4) seizing the day: how women can level their own playing field; and (5) small and women’s colleges: What are their special roles and issues?

Two important statistics stood out from the presentations at the WIA II conference. First was the recognition that approximately one fourth of professional astronomers are women. Second was that 50-60% of AAS members aged 18-23 were female, undoubtedly influenced by the high fraction of women in the NSF-sponsored program

of Research Experiences for Undergraduates (REU) [3]. Clearly, the field continues to attract women and benefit from their participation. However, the data also seemed to show that women were still less likely to advance than their male colleagues [4]. Thus, in order to enable future progress toward parity, the meeting participants recommended that our field evaluate itself periodically and implement changes based on the latest demographic data and the most successful solutions. Furthermore, the conference participants concluded that there are clearly still many ways that various institutions can improve their working environment.

While there are no formal proceedings from this meeting, many of the talks are available online, linked from the website for the Committee on the Status of Women, <http://www.aas.org/cswa/WIA2003.html>.

3. THE PASADENA RECOMMENDATIONS

As noted in the previous section, the opportunity to work towards gender equity lies within the astronomical community. Therefore, the CSWA developed a new set of recommendations for progress, “Equity Now: The Pasadena Recommendations,” using input from both the Pasadena meeting participants and the larger AAS community. While these Recommendations emphasize the academic sector due to its unique influence on the future of the field as a whole, the document notes that these problems are not limited to either academia or astronomy. Thus, the document calls on all scientists to work together toward equality. In addition, the Recommendations advocate that the strategies developed for the sake of encouraging gender equality be adapted to address the even slower advancement of minority scientists. Below is a list of the guiding principles and main focus areas of the Recommendations. For complete details, they are posted off of the CSWA website at <http://www.aas.org/cswa/pasadenarecs.html>.

The guiding principles of the Pasadena Recommendations are:

- Women and men are equally talented and deserve equal opportunity.
- Full participation of men and women will maximize excellence in the field.
- The measure of equal opportunity is outcome, i.e., gender equity will have been attained when the percentage in the pool equals the percentage in the next level of advancement.
- Long-term change requires periodic evaluation of progress and consequent action to address areas where improvement is necessary.

The focus areas of the Pasadena Recommendations are:

- Tenure-Track Hiring
- Career Advancement and Recognition
- Institutional Policies

- Varied Career Paths
- Cultural Issues
- Statistical Information

“Equity Now: The Pasadena Recommendations” was unanimously endorsed by the AAS Council in January 2005. This represented a step forward from the 1994 endorsement of only the “goals” of the Baltimore Charter.

CONCLUSIONS

While there has clearly been overall “buy-in” by the astronomical community to the necessity of actively promoting gender equity, anyone who reads both the Baltimore Charter and the Pasadena Recommendations will notice a significant amount of overlap—there are still many areas where progress can and should be made. The CSWA chose several focus areas to try and maximize its impact. One focus was promoting endorsement of the Pasadena Recommendations by individual departments and institutions. A list of institutions that have endorsed the Recommendations is maintained on the CSWA web site. The CSWA has also published a brochure of the Recommendations, and recently included an additional brochure entitled “What Can I Do?” which focuses on actions individuals can take to promote gender equity. Furthermore, a CSWA-based subgroup is working with the AAS and AIP to design a long-term, longitudinal study of astronomers as they progress through their careers, targeting all astronomy and astrophysics graduate students in the 2005-2006 school year. This type of study is necessary for the establishment of reliable, well-understood statistical information, and to address why astronomers make the career choices they do at every step along their path, including those who choose to leave the field. The results of the first survey in this study were presented separately in these proceedings (see the paper by Rachel Ivie of the AIP). Finally, the WIA III meeting that has resulted in these proceedings was organized with a much stronger emphasis on diversity as a whole and addressing the severe under-representation of minorities in our field. The community continues to work to ensure that equity is achieved, and hopefully one day the content of the Pasadena Recommendations will be so ingrained in our community that the Recommendations will be remembered only for their historical significance.

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The International Year of Astronomy 2009

Pedro Russo¹ on behalf of the IAU IYA2009 EC WG

As the International Year of Astronomy 2009 (IYA2009) comes to a close, the true scope of the venture is becoming clear. The Year was launched by the International Astronomical Union (IAU) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) under the theme “The Universe, Yours to Discover.” Since its inception, IYA2009 was planned to be more than just a series of activities occurring over 12 months. It has been designed and implemented as a springboard for the popularisation of astronomy with a much longer timeframe in mind.

Abundant in grass-roots initiatives and global projects, this venture has been highly visible and its impact will last for years. Perhaps the most impressive statistic from IYA2009 is the sheer size and scale of the astronomy network that has been created: the largest in history. One-hundred-forty-eight countries, from Afghanistan to Zimbabwe, joined together to work toward the common goal of making astronomy accessible to all; the International Year of Astronomy 2009 truly has been international! Individuals and groups in all of these countries have been collaborating both internally and across borders on projects beneficial to us all. The relationships forged between scientists, communicators, teachers, and enthusiasts during IYA2009 should remain far into the future, and it is hoped they will only become stronger with time. As IYA2009 has shown, sharing resources and expertise is a win-win situation.

A RECORD-BREAKING YEAR

Most of the incredible initiatives have come from individual countries. During 2009 more than one million Canadians have experienced a so-called “Galileo moment,” an engaging astronomical experience that has opened their eyes to the Universe. In Portugal more than 300,000 people participated in this year’s astronomy-themed Oceans festival. It featured a Guinness World Record 4.8-km long canvas painted with the help of enthusiastic volunteers. In Japan more than seven million people were outside stargazing during 2009.

The IYA2009 presence in the news media sphere has been tremendous: the number of IYA2009-related blog entries and tweets reached millions. The IYA2009 Cornerstone Project Cosmic Diary, a blog where 60 professional astronomers from around the world blog about their lives, families, friends, hobbies and interests, as well as their work, had more than 250,000 visitors and more than 2100 blog entries. As another

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example, more than 10,000 people participated in Meteorwatch on Twitter, making this the first event of its kind, and also one of the biggest mass-participation events of IYA2009. On both nights of the Perseid meteor shower it was the #1 top “trending topic”; by far the most-discussed topic on the Twitter network anywhere in the world!

PLANET-WIDE IMPACT

The global IYA2009 projects have also been more successful than anyone initially dared to imagine. Two worldwide star parties were held in 2009: 100 Hours of Astronomy in April, and Galilean Nights in October. In total more than three million people got involved, with many members of the public seeing night sky objects such as planets and the Moon through a telescope for the very first time; a life-changing experience for many. A record-breaking and unprecedented live 24-hour webcast called *Around the World in 80 Telescopes* was a true highlight during 100 Hours of Astronomy. Featuring astronomical research observatories both on and off the planet, the webcast gave members of the public a snapshot of life at research observatories around the world during a single 24-hour period, showing viewers the wide range of astronomers’ activities at many, often very different, observatories. The marathon webcast, which had at least 200,000 viewers worldwide, gave a striking demonstration of the global diversity of astronomical research.

Seventeen developing countries, namely Macedonia, Nepal, Uganda, Mongolia, Nicaragua, Nigeria, Kenya, Ethiopia, Gabon, Rwanda, Uruguay, Tajikistan, Ghana, Trinidad and Tobago, Mozambique, Pakistan and Tanzania, have received seed grants to stimulate astronomy educational and outreach. Their activities span from astronomy education workshops for teachers, recording and preservation of indigenous astronomy knowledge, production of school astronomy education resources in local languages and many more.

INFLUENCING POLICY-MAKERS

Political interest in IYA2009 was also high, which in itself is an achievement for any popularisation initiative. In the United States of America, the House of Representatives passed a resolution supporting IYA2009. The Spanish Congress of Deputies also passed a law supporting astronomy in the framework of IYA2009. Heads of State were keen to express their support for the Year. The President of the Portuguese Republic, Prof. Dr. Aníbal Cavaco Silva, personally presided over the Portuguese IYA2009 Honour Committee. The President of the Republic of Slovenia, Dr. Danilo Turk, became the patron of IYA2009 in Slovenia. Lech Kaczyński presided over the Polish IYA2009 Honour Committee, while Prince Felipe of Spain (Prince of Asturias) did the same for

the Spanish IYA2009 Honour Committee. The former Belgium Prime Minister and current President of the European Council, Herman Van Rompuy, voiced support of astronomy during an IYA2009 event in Belgium held in April 2009.

The former European Commissioner for Science and Research and present European Commissioner for Environment, Janez Potočnik, expressed his support of astronomy during the European opening of IYA2009 in Prague, Czech Republic. In the US, the event celebrating IYA2009 at the White House with President Obama and the First Family on the 5th October 2009 made headlines. In Nepal the total solar eclipse observation event on the 22nd July 2009 was attended by the Prime Minister of Nepal, Madhav Kumar together with thousands of members of the public. Iran's President Mahmoud Ahmadinejad pointed that IYA2009 provided a chance for young scientists to develop a more vivid vision of man's future during his inaugural speech of the third International Astronomy and Astrophysics Olympiad in Tehran, Iran. Pope Benedict XVI gave an eloquent speech in which he said "The International Year of Astronomy is meant not least to recapture for people throughout our world the extraordinary wonder and amazement which characterised the great age of discovery in the sixteenth century."

CROSSING BORDERS AND BRIDGING BOUNDARIES

Some projects crossed country borders in a literal sense. The GalileoMobile was a science education itinerant project that spent two months bringing life-changing experiences and the excitement of astronomy to young children in Chile, Bolivia and Peru. In total the GalileoMobile visited around 3000 children in 30 schools, covering a distance of 7000 km. Tunisia's Astro-Bus was a similar project. From January to September the Astro-Bus visited around 60 regions throughout the country, crossing approximately 15,000 km, sharing its content with 100,000 Tunisians of all ages. Telescopes have also travelled more than 20,000 km across Argentina, providing thousands of people with the opportunity of observing the firmament through a telescope.

A SPRINGBOARD TO SUCCESS

The International Year of Astronomy 2009 was never seen as a "one-off" event lasting just one year, but as a means of creating structures for collaboration, lasting self-sustaining activities and innovative concepts for the communication of astronomy. Most of the IYA2009 Cornerstone projects will continue beyond 2009 unchanged or in a slightly changed form. The maintenance of the IYA2009 networks is one of the priorities of the IYA2009 legacy and the global networks will continue to operate and engage millions of people.

Some of the Cornerstones will be incorporated into International Astronomical Union (IAU) plans. A prime example is Dark Skies Awareness, since participation in the protection of the sky is an essential duty of the IAU. Thanks to Developing Astronomy Globally and also to the general networking effort, developing nations have enjoyed increased links with astronomy groups and organisations at home and abroad. New openings and opportunities at both the professional and amateur level instigated during IYA2009 are set to continue, allowing expertise within these countries to be maximised, and helping global astronomy research and science communication. The IAU has been at the forefront of these efforts, and consolidating links between the IAU and developing nations is seen as a priority in the brand new IAU Strategic Plan for Astronomy Development. From the IYA2009 networks, we know that efficient organisation is the foundation of success. This is when having an organisation like the IAU to coordinate efforts really comes into its own. Education was a strong theme during the Year, emphasised in particular by the Galileo Teacher Training Cornerstone, and there is much potential in building on the existing efforts to extend the reach of science in general and astronomy in particular, on a world level. Thus, IYA2009 is a springboard for the enhancement of IAU educational activities as set in the Strategic Plan.

Combining increased opportunities for developing nations with improved education, the Universe Awareness project (UNAWA) tackled difficult issues head-on during IYA2009. Its aim of creating an international awareness of our place in the Universe and on Earth, targeted at children in underprivileged environments, has inspired many. Clearly this programme must continue in 2010 and beyond.

Providing a wealth of educational material is a factor that deserves to be highlighted. During IYA2009 resources were disseminated and put to good use. Celestron and Japanese “You are Galileo” telescopes, as well as large numbers of Galileoscopes have been donated, mainly to developing countries. The Galileoscopes, low-cost telescope kits, result from one of the IYA2009 cornerstones, allowing educators to utilise excellent quality, but accessible tools to improve their astronomy communication. Galileoscopes will continue to be sold after 2009, but at a higher price.

Other cornerstones, and most of the special projects, will also survive 2009. Large steps forward have been made for the designation of astronomical sites by the UNESCO World Heritage programme. These give historical sites prominence and prestige, and help ensure that the public is aware of their importance. More work remains to be done in the coming years. Protecting and preserving our astronomical cultural heritage for future generations to appreciate must remain a priority.

She Is An Astronomer, which promotes gender-equality, has gathered much interesting material on its website and will soon hold an international workshop in England. In conjunction with the Cosmic Diary, this cornerstone can help to present a modern image of astronomers to the public. The stereotype of oddball figures with long beards in towering observatories is not only inaccurate, but also damaging. Helping to reshape preconceptions and expectations is notoriously difficult, but also necessary. The extent to which IYA2009 has had a positive impact in this area will only be known with time.

Last but not least, large-scale public observing programmes, following the model of the famous worldwide events, 100 Hours of Astronomy and the Galilean Nights, will continue to be organised.

A BRIGHT FUTURE?

It is hoped that IYA2009 has fostered: an increased awareness by society that we are living in an extraordinary era of discoveries about the Universe; a modern image of astronomers in the eyes of the public; a clear demonstration that a career in astronomy is also for women and minorities; the creation of international networks of scientists, communicators, teachers and amateurs, which should remain in existence far beyond 2009; a wealth of educational material on astronomy, books, films, movies for television, DVDs, theatre, planetarium shows, and music related to astronomy; the inception of a new set of goals for the IAU embedded in the Strategic Plan, of a partnership between IYA2009 and UNESCO; and the birth of many vocations at the professional and amateur level.

Celebrating 30 Years of Advancing the Status of Women in Astronomy: The AAS Committee on the Status of Women in Astronomy

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SUMMARY

The Committee on the Status of Women in Astronomy was established in 1979. Its charge is to recommend to the AAS Council practical measures that can be taken to improve the status of women in astronomy and encourage their entry into this field. CSWA has addressed issues such as discrimination, harassment, the two-body problem, and work-life balance. We have several print and electronic publications, have held three international meetings about the status of women in astronomy, and host special topical sessions and brown-bag lunches at most American Astronomical Society meetings.

1. WHAT WE DO

The charge to the Committee is to recommend to the AAS Council practical measures that the AAS can take to improve the status of women in astronomy and encourage their entry into this field.

Pursuant to this, we publish a weekly electronic newsletter, AASWomen, with timely news items, advice solicitations and responses, and job postings relevant to women in astronomy. Contributions are welcome from anyone, and anyone may subscribe.

Information on contributing, subscribing, as well as past issues is available at:

<http://www.aas.org/cswa/AASWOMEN.html>.

We also provide access to STATUS: a semi-annual publication of original and reprinted articles on topics relating to women in astronomy, science, and in society. Contributions such as editorial columns, factual articles, personal stories and letters to the editor are welcome from anyone. Information on contributing, subscribing, and past issues is available at: **<http://www.aas.org/cswa/STATUS.html>.**

The Committee also maintains the Women in Astronomy Database, and the Women in Astronomy blog (**<http://womeninastronomy.blogspot.com/>**).

We have organized three international meetings (Women in Astronomy I, II, and III in 1992, 2003, and 2009) and sponsor informal brown-bag luncheon discussions at most AAS meetings. The first two WIA meetings resulted in the Baltimore Charter and Pasadena Recommendations (see below).

2. HOW IT WORKS

- **History**

The CSWA was established June 1, 1979.

- **Members**

Currently, there are ten members—six women and four men. The council appoints members in the month of June from a list of volunteers. The committee was enlarged this year from the previous size of five people.

- **Term**

Each member serves three years, from June to June. The terms are staggered from the close of one Annual Members' Meeting to the close of the next Annual Members' Meeting.

- **Chair**

The chairperson is elected by the committee members for a one year term, serving from the June business meeting to the next June business meeting.

3. RECOMMENDATIONS

The Baltimore Charter and Pasadena Recommendations are documents produced as a result of the Women in Astronomy Meetings held in Baltimore in 1992 and Pasadena in 2003. The first document describes a code of conduct governing gender issues, particularly aimed at U.S. institutions, while the latter document is a set of recommendations for institutions hoping to achieve true gender equity. There are links to the individual documents and meetings on the CSWA website that provide much more information.

4. WHAT YOU CAN DO

- **The Pasadena Recommendations**

The President of the AAS and the Chairperson of the CSWA have asked that astronomical institutions formally endorse the Pasadena Recommendations. You can ask your institution to formally endorse these Recommendations by following the instructions at: http://www.aas.org/cswa/pasadena_endorse.html.

- **Get Involved**

If there is an issue that you think needs more attention, please contact a CSWA member.

5. RESOURCES

We have links to many resources on our website, including:

- **Women in Astronomy Database**
 - Information and Help
 - Direct Database Access
- **Meetings**
 - Women in Astronomy I (1992)
 - Women in Astronomy II (2003)
 - Women in Astronomy III (2009)
 - Past AAS and Non-AAS Meetings
 - Anti-Harassment Policy for AAS Meetings
- **Statistics**
 - Departmental Surveys
 - AWIS Statistics
 - AIP Statistics
- **Advice**
 - Top Ten Ways to be a Better Advisor for Graduate Students
 - Advisors, How Do You Deal with Student Tears?
 - Yes, Virginia, Discrimination and Harassment Do Still Happen
 - Advice on When to Raise a Family
 - Advice for Postdocs Applying for Tenure-Track Position
 - The 2-Body Problem: New Advice for an Old Problem?
 - Being Ignored in a Meeting: Suggested Solutions
 - How to Be a Good Mentor
- **External Links – Women and Science Relevant**
 - Organization
 - Articles, Resources, and Database

6. FOR FURTHER INFORMATION

Please contact cswa@aaas.org, or check out our website at: <http://www.aas.org/cswa>; where you will find links to most of the topics listed here.

The IYA2009 Cornerstone Project *She Is An Astronomer*

Helen J. Walker, STFC Rutherford Appleton Laboratory, Didcot, OX11 0QX, UK
On behalf of the *She is an Astronomer* Task Group

SUMMARY

Gender equality and empowering women is one of the United Nations' millennium development goals. The aim of the IYA2009 cornerstone project, *She is an Astronomer*, is to provide information to female professional and amateur astronomers, students, and those interested in the gender equality problem in science. An objective of the project is to build and maintain an easy-to-handle forum and database, where people can get information about the subject, ask questions and find answers. The main areas where information is being gathered are: (1) profiles of living and historic female astronomers, a largely invisible part of the astronomy community in the past; (2) resources available to women astronomers; (3) events taking place during the year; (4) an area for national ambassadors of *She is an Astronomer* to populate with information; (5) a forum where issues and topics can be discussed. Women from around the world are taking part in this project and as IYA2009 progresses the website is growing. At the end of the IYA2009 the website and the information gathered on it will be retained and maintained as a legacy from IYA2009.

INTRODUCTION

The *She is an Astronomer* website (www.sheisanastronomer.org) was launched in April 2009 and immediately astronomers were getting in touch with news and events. This is an international project and people from 91 countries have visited the website. It is averaging around 2000 visits per month. The profiles of more than 30 female astronomers from 16 different countries are accessible on the website and more are being added each month. The profiles are from women at all stages of their careers, doing a wide variety of jobs. Some filled in a questionnaire we sent out while others wrote their own essay on their life and career. We have profiles for around 20 female astronomer pioneers—women whose work has often been invisible and not recognized. There are examples of the different types of events that people are holding to celebrate *She is an Astronomer*, and there are a lot more events taking place. The web forum (forum.sheisanastronomer.org) started in October 2009 and already has over 40 members, split almost equally between men and women. There are a lot of visitors to the forum and we are getting new members and new posts every day.

FROM THE PROFILES

The profiles we received show that women have a real passion for astronomy—they love doing it. They will work hard and put in long hours. They think the situation for women is getting better but active support is needed—and this gave rise to a resolution being presented to the International Astronomical Union (IAU) General Assembly in August 2009. We asked women if they had been discriminated against during their career, and many said they thought that they personally had not suffered discrimination. Yet almost everyone said that women were underrepresented at senior levels (in their country) compared to junior levels. One of the questions in the profile is, “What recommendation would you make to young women starting their career in astronomy?” This has provided to be an amazing resource of hints and suggestions. We are urged to learn how the system works, join committees, get information and support, and give talks.

- **For the individual:**

- Do what you enjoy
- Be flexible
- Keep a positive attitude
- Pick the one thing you excel at
- Don't be put off
- Break the job down into small parts
- Publish faster
- Get a mentor
- Get a life
- Start your family (if you want one) when you are young, energetic and flexible

- **For the family:**

- Find a supportive partner
- Train your partner
- Explain to your family about your work and why you enjoy it, and this will help them support you
- Discuss issues, and keep discussing issues
- Remember the two-body problem is hard for both partners

EVENTS AND ACTIVITIES

There have been a wide variety of events and activities in 2009, celebrating women as astronomers and scientists, aimed at encouraging the next generation. A selection of events is listed below to give people ideas and spark some new ones:

- Spanish astronomers created a calendar celebrating female pioneers (now translated into English for 2010).
- Romanian astronomers handed out IYA2009 badges on 8 March to women to celebrate International Women's Day.
- Turkish astronomers visited schools to show the children that astronomers are female too.
- America held camps for girl scouts and for photographers.
- Korea included a female astronomer in their 'meet an astronomer in the classroom' programme.
- India included three female astronomers in their film on astronomy to be sent to schools.
- Saudi Arabia organised lectures describing the universe, especially for women.
- Tunisia held a meeting on 7 March with lectures by women scientists organised by the Ministry for Women's Affairs, Family, Children and the Elderly.
- Germany and Australia are holding exhibitions celebrating female astronomers.
- Italy, Belgium, Ireland and the UK held meetings featuring female astronomer speakers.
- America held a workshop on inspiring young women to stay in astronomy.
- Russia held a meeting to celebrate the work of their senior female scientists.
- Australia is launching a book about Ruby Payne-Scott, a pioneering radio astronomer.

E-MENTORING: A NEW INITIATIVE

One of the issues that has been raised at various times is that of mentoring. Many of the women who submitted profiles said how much it had helped them and recommended it to other women. Some women found it more helpful to have several mentors, covering different aspects of their work. There are various types of mentoring, but the model considered by *She is an Astronomer* is that of one-to-one discussion about work and work/life balance, in order to help the mentee make their own (informed) decisions. Normally mentoring is done with face-to-face meetings, but for many female astronomers this is not easy because they are the only female astronomers they

know. *She is an Astronomer* is exploring ways in which this could be done via email, telecon, videocon, and Skype. The main issues are how to train mentors and mentees, and how to pair people as mentors and mentees. MentorSET in the UK has a very useful questionnaire which they use to guide the pairing and a helpful “contract” to enable both people to understand the topics for consideration, and a duration for the mentoring (which can be reviewed). Female astronomers and planetary scientists at international meetings in 2009 were very interested in participating in such a scheme.

BUILDING ON THE IAU RESOLUTION

The IAU resolution (B4) presented to the General Assembly recognized that individual excellence in science and astronomy is independent of gender, and that gender equality is a fundamental principle of human rights. The IAU resolved that IAU members should encourage and support the female astronomers in their communities, and that IAU members and National Representatives should encourage national organizations to break down barriers and ensure that men and women are given equal opportunities to pursue a successful career in astronomy at all levels and career steps. Each IAU member and each National Representative knows their community and where their effort should be best focussed and where support and encouragement is most needed in their community: school, university, early-career, and late-career.

Here are some suggestions; hopefully one or two will be helpful.

- **How the individual can support female astronomers:**

- Be aware of attitudes.
- Be actively inclusive and challenge inappropriate comments
- Encourage good practice
- Nominate female colleagues for awards, committees, promotions, etc.
- Help and advise female colleagues, encourage them to apply for jobs, promotions
- Invite female astronomers to chair conference sessions, encourage women speakers

- **This is how your area can support female astronomers:**

- Enforce/encourage appropriate action (e.g. Baltimore charter recommendations, quotas, affirmative action, flexible working, university admission policy, school admission policy)
- Enforce and finance good practice recommendations
- Funding support (to address two-body problem, returners, childcare)
- Gather statistics so the situation is quantified at each stage of career structure
- Ensure committees have more than one female member
- Ensure nominations are balanced

CONCLUSION

IYA2009 and the *She is an Astronomer* Cornerstone Project has been an enormous success for raising awareness that women can do astronomy, and should be encouraged and supported. Now we all need to build on this to make the gender equality a reality.

VIII. HISTORY



Votive disk of Enheduanna, found at Ur, ca. 2300-2275 BCE. Alabaster. University of Pennsylvania Museum of Archaeology and Anthropology, Philadelphia, PA.

Scholars and Sorceresses: Ancient Women Astronomers¹

Diana Khachadourian, ASRC/GSFC

SUMMARY

Astronomy, as one of the most ancient sciences, has a long tradition of women who knew and studied the discipline. Most ancient societies were male-dominated, but as in all societies—both ancient and modern—strong and intelligent women managed to make their mark in the world of science. By expanding and applying their knowledge (and some by sacrificing their lives), women gained a place in history—a place that cannot be ignored simply because they were women. The intellectual capacity of ancient female scientists, such as Enheduanna, Aglaonike, and Hypatia provided women an indisputable place in the history of astronomy.

INTRODUCTION

For the ancients, the heavens inspired awe, fear and curiosity. Those who possessed knowledge of the sky and appeared to unlock its mysteries were idolized, revered, or persecuted. Although scribes often masculinized the names of ancient female scientists (see Keyser and Irby-Massie, p. 1029), we do know that some of the first ancient astronomers were women. This paper will examine women in astronomy from an historical perspective. It will examine what we know of their lives and of the attitudes that their societies held toward them. In particular, this paper will focus on three ancient female astronomers: Enheduanna, the Akkadian high priestess of the moon-god Nanna who lived over four thousand years ago; Aglaonike of Thessaly, who predicted lunar eclipses; and Hypatia of Alexandria whose violent death at the hands of an angry Christian mob has inspired centuries of scholarship and speculation.

ENHEDUANNA

Enheduanna (2285-2250 BCE), the Akkadian high priestess of the moon-god Nanna, is known to us through her forty-two surviving hymns and three devotional poems. She is the first author in history to have written in the first person. Her works are the oldest surviving pieces of literature in Western civilization.

Over four millennia ago, Enheduanna, whose name means “High Priestess, Ornament of the Sky,” held one of the most important positions in her native Akkad (modern day Iraq). The daughter of King Sargon the Great, she was appointed high priestess of the moon-god Nanna by her own father. The only surviving representation of what may be one of the first

¹N.B. This paper is presented as an abstract of a work that is still in progress.

ancient female astronomers, a disk with a bas-relief that is now in the University Museum in Philadelphia, shows Enheduanna standing behind a priest who is making a libation. On the back of the restored alabaster disk there is an inscription that identifies Enheduanna as the priestess of Nanna and the daughter of Sargon. On the left front of the disk is a stepped building that, in this author's opinion, is the representation of a ziggurat (see also McHale Moore article, p. 69). Ziggurats are large stepped buildings that were erected in the temple complexes of Mesopotamian cities. The stepped platforms ascended to small temples or sanctuaries at the top. Diodorus Siculus, in his *Bibiloteca Historica* (1st Cent. BCE) suggests that Mesopotamian priest-astrologers used these edifices as observation platforms (II 9.4.).

The true woman who possesses exceeding wisdom...
She consults a tablet of lapis lazuli,
She gives advice to all lands...
She measures off the heavens,
She places the measuring cords on the earth
Nisaba praise! [Enheduanna, #42, ll.536, 538-539, 541-542]

Enheduanna often mentions herself in her poetry as priestess and singer of the gods' praises. The poem quoted above is dedicated to Nisaba, the goddess of writing and knowledge. "She measures off the heavens, she places measuring cords on earth," are intriguing lines that, at first, may not seem to fit the role of the goddess of writing. But Nisaba has a direct connection to the sky. She is the daughter of the sky god An, who, in turn, is the son of Nammu, a female deity who created both the earth and the heavens in Sumerian mythology. A Babylonian hymn written to Nisaba says: "He...[name missing] has organized pure food-offerings: he has opened up Nisaba's house of learning, and has placed the lapis-lazuli tablets on her knees, for her to consult the holy tablet of the heavenly stars" (ll.27-35). Both of these hymns make a clear reference to Nisaba's connection with the sky.

Mesopotamians undoubtedly knew and studied astronomy, but it may be difficult to accept that Enheduanna was an astronomer in any modern sense. As high priestess to one of the most important gods in the Sumerian pantheon, she would have had several functions. One of these functions was as the earthly consort of the moon god. Enheduanna was the interpreter and intermediary between the divine and secular worlds.

Any assumption that the thousands of clay tablets that survive from Mesopotamia with astronomical writings were all written by men would be archaic and rash, particularly in light of current evidence. Enheduanna's writings confirm that she was highly educated; this education would include knowledge of astronomy.

Predicting events such as lunar and solar eclipses possessed a huge magical potential in Mesopotamia and the rest of ancient world. In a society such as Sumer's, whose population was mainly uneducated and illiterate, those who could predict these phenomena were held in high esteem. To be able to foretell the flooding of a river for the purposes of planting and then harvesting of crops was of the utmost importance to an agrarian society. As such, Enheduanna was a powerful figure in the city of Ur. As high priestess and ritual wife of Nanna, she was a close observer of the heavens. Although we have no technical writings from Enheduanna, her position would, by definition, have had to include informed observation of the heavens—that is, astronomy.

AGLAONIKE

Aglaonike, whose name translates as “Luminescent Victory,” was considered a sorceress (schol. AR. 4.59). She was said to have had the ability to predict lunar eclipses and to “bring down the moon.” Not much is known of Aglaonike, except that she was the daughter of a certain Hegetor of Thessaly; her dates are uncertain. But the few times she is mentioned, the ancient sources allow us to believe that she was one of the first recorded female Greek astronomers.

Unlike other ancient cultures, Greek religion and myth incorporated little magic and sorcery. In their pantheon, the Greeks saw gods who were kind, petulant, angry, and love-stricken—their conditions mirrored human conditions. If the classical Greeks did not delve into magic, why is it that Aglaonike was considered a sorceress? The answer to that question lies in her geographic origins.

Situated in northern Greece, Thessaly had a long tradition of sorceresses. In the twelfth century BCE peoples from the north and northwest invaded Thessaly. These invaders brought the tradition of magic with them—a tradition that lasted well through classical times. In myth, the most famous of these Thessalian sorceresses was Jason's wife, Medea. She was the daughter of the king of Colchis, a region of the Caucasus in western modern-day Georgia—the very area from which the historical invaders came. With her knowledge of magic, Medea helped Jason obtain the Golden Fleece through his arduous voyage on the *Argo*.

The bringing down of the moon was a characteristic trait of Thessalian women (Sosiphus of Syracuse, *Meleager*, TrGF92 F1 and Statius, *Thebad* 3.558-559), but if her own people viewed Aglaonike as a sorceress, such was not always the case of later authors. In his *Moralia*, Plutarch, the second century Greek historian, essayist, and biographer, writes:

If someone undertakes to draw down the moon, she [a woman who understands mathematics] will laugh at the ignorance and stupidity of the women she takes in, for she will not be unfamiliar with astronomy, and will have heard of Aglaonike, the daughter of the Thessalian Hegetor. She knew all about total eclipses of the moon, and able as she was to predict the occasions on which the moon is overtaken by the shadow, she used to trick the women and make them believe that she was drawing down the moon herself. (145cd)

Here, Plutarch clearly sees Aglaonike as a scholar. He alludes to her being a trickster but ridicules those who would believe in this phenomenon as “magic.” He tells us that, through her knowledge of mathematics and astronomy, Aglaonike was able to trick those who did not know these sciences.

It may be argued that Aglaonike is not an historical figure. But to omit her name when trying to trace the history of ancient women astronomers would be a mistake. Aglaonike must be seen as at least symbolic of those women in Thessaly who were versed in the science of astronomy. The persistent and pervasive mention of these women in ancient sources (though not always by name) allows us to acknowledge a long tradition of female astronomers in ancient Thessaly (Plato, *Gorgias*, 513a. Aristophanes, *The Clouds*, 1.749).

HYPATIA

The undisputed and most famous female scholar in the ancient Greek world is Hypatia of Alexandria. We use the word scholar, and not philosopher or scientist, because *scholar* encompasses all disciplines. In the ancient Greek world, science, art, religion, literature, mathematics, and philosophy were intertwined (and, in fact, were often synonymous). Although Hypatia is most often described as a philosopher, a teacher of Neo-Platonism, in her time she would have been familiar with all disciplines. Born around 355 CE, she was the daughter of Theon, a mathematician and astronomer. Hypatia would most likely have learned these two disciplines from her father.

Compared to the meager historical traces that define Aglaonike, we have ample ancient written sources to give us a much more substantial view of Hypatia’s life and her times. Three short surviving biographies: Socrates Scholiasticus, 5th century, (*Ecclesiastical History*); Damascius, late 5th and early 6th centuries, (*The Life of Isidor*); and John, the Bishop of Nikiu, 7th century, (*Chronicles*, 84.87-103). Although each no longer than one written page, all three refer to Hypatia’s vast knowledge. Socrates Scholiasticus describes her as surpassing all philosophers of her time through her knowledge of literature and science. Damascius mentions that Hypatia, besides devoting herself to all of philosophy and surpassing her own scholar father with her genius, wrote *The Astronomical Canon*.

(No works by Hypatia survive.) The later author, John of Nikiu, takes an early Christian view of Hypatia and mentions that, “she was devoted at all times to magic, astrolabes and instruments of music...” All three authors describe her violent death.

A fourth and perhaps most important source for knowledge of Hypatia is Synesius of Cyrene. Synesius left hundreds of letters, some of which are addressed to Hypatia. Although Synesius offers little biographical information about Hypatia in these letters, he is noteworthy because he is her contemporary. Born in Libya, as a young man Synesius traveled to Alexandria and became a student of Hypatia. In Alexandria, then a great center of scholarship, he, along with many others, probably both pagans and Christians studied Neo-Platonism and other disciplines with the most famous female teacher of the time.

It may seem that Hypatia does not fit into the line of ancient female astronomers but in a letter to a certain Paeonius, Synesius writes:

I am therefore offering you a gift befitting for me to give, and for you to receive. It is a work of my own devising, including all that she, my most revered teacher, helped to contribute, and it was executed by the best hand to be found in our country in the art of the silversmith. (no.115 *De Dono Astrolabii*)

This letter, too long to include here in its entirety, accompanied the gift of an astrolabe. The teacher is undoubtedly, Hypatia. Synesius himself may well have designed the astrolabe with the help of his “revered teacher.” In another of his letters (no. 15), Synesius asks Hypatia for her help in building a hydroscope and goes on to describe exactly how it is to look. Hypatia must have had knowledge of these instruments and must have had the wherewithal within the scientific and skilled-crafts community to have them built. As a student of all knowledge, Hypatia did not stop at philosophy but must also have been versed in the sciences of her day, certainly including astronomy.

Hypatia lived in turbulent times. In the late fourth and early fifth centuries, Alexandria was a cauldron of various (and competing) cultures and religions. With Christianity beginning to take a greater hold, those who did not adhere to the rising faith were regarded with caution. Non-Christian religious factions were violently suppressed and persecuted. The two patriarchs during Hypatia’s lifetime, Theophilus (385-412) and Cyril (Bishop of Alexandria from 412, d. 444), were both zealous in their suppression of Jews and Pagans. Hypatia was not only a Pagan, but also an intellectual. Her violent death at the hands of the angry Christian mob was directly connected to her influential standing in Alexandria.

As a teacher, she would have been able to impress her mostly young students, a reality that may not have been well regarded by the Christian patriarchs. The early Christians would have seen her teachings in philosophy, mathematics, astronomy, etc., as heretical. She was a

danger to the growth of Christianity and the political power the Christians were beginning to enjoy. In 415, Hypatia was captured by surprise and dragged through the streets of Alexandria until she was dead. Her body was then torn to shreds and burned. Whether Cyril had a hand in this, we may never know. No evidence indicates that he gave specific orders to have her murdered.

Although veiled by religion, Hypatia's murder was spurred by politics. The early Christians of Alexandria could not afford to have an intelligent, learned, powerful Pagan female in their midst; she was a direct threat to their patriarchal rule.

CONCLUSION

To deny the existence—or importance—of ancient female astronomers would be an intellectual blunder and a disservice to history. Not all of the women who practiced astronomy were called astronomers. In the context of the ancient mingling of science with religion and philosophy, scholars must survey the very wide range occupied by curious and learned women in order to discern those women who contributed vital elements to the foundation of the astronomy and astrophysics of today.

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Women's Work¹

For women in science a fair shake is still elusive

Vera Rubin, Department of Terrestrial Magnetism, Carnegie Institute of Washington

I was an astronomy student at Vassar College on October 1, 1947, one hundred years after the night that Maria Mitchell discovered a comet. Only recently have I realized that no note whatsoever was taken of the centennial of this discovery by the first prominent female astronomer in the United States. Perhaps on that day one of my friends or I irreverently tied a bright scarf around the stern-looking bust of Mitchell in a niche of the observatory building, where she taught for many years. But she deserved more.

What I do remember of 1947 is that I wrote a postcard to Princeton University asking for a catalog of the graduate school. Sir Hugh Taylor, the eminent chemist and dean of the graduate school, took the effort to answer by writing back that as Princeton did not accept women in the graduate physics and astronomy program, he would not send a catalog. Princeton did not accept women in graduate physics until 1971, in graduate astronomy until 1975, and in graduate math programs until 1976.

For me as a youngster, the account of Mitchell's comet discovery that I found in the library books was an exciting part of the lore of the scientific past, along with Benjamin Franklin's kite. Like the kite it should be part of every American child's heritage. Yet in 1976, when the Smithsonian Air and Space Museum presented as its first planetarium show a history of 200 years of American astronomy, only male astronomers—all but one of them white—were included. Little boys learned that they could become astronomers. But little girls, who also streamed into the show in enormous numbers, saw that only men were astronomers. After months of effort to have the planetarium show corrected, I received a statement that the talk was recorded and could not be altered.

All of us, men and women alike, need permission to enter and continue in the world of science. In high school and college, students need the permission of parents and teachers. During graduate and postgraduate years, young scientists need the permission of college officials, funding officers, mentors, and colleagues. While such permission has generally been granted to bright men, it had always been less readily granted to young women and continues to be denied to many women even today. In many fields of science, women constitute such a distinct minority—less than five percent of all physicists and seven percent of all astronomers—that they suffer many of the social ills common to minorities.

In Colonial America, public education for women was practically nonexistent. But starting about 1820, women's academies came into vogue, and science was part of the curriculum. By 1871, eighteen of these schools had observatories and offered a course in astronomy.

¹This article first appeared in the July/August, 1986 issue of *Science* magazine (p.58-65). The italicized sections at the end of the piece are the author's recent additions.

Nevertheless, throughout most of the 19th century, women in the United States were usually dependent upon a supportive male relative to introduce them to the world of science. For Maria Mitchell it was no different.



Maria Mitchell (second from left) and her students.

The daughter of an intellectual Nantucket family, Maria Mitchell learned from her father how to search the sky with a telescope and how to calculate orbits. Employed during the 1840s and 1850s as the librarian of the Nantucket Athenaeum—the intellectual center of Nantucket and home of the literary and philosophical societies, where giants like Thoreau, Agassiz, and Audubon lectured—she studied the advanced astronomical and mathematical texts available to her. Evenings she spent with her father on the roof of their home studying the sky with a telescope. On October 1, 1847, while her parents were downstairs entertaining guests at dinner, the twenty-nine-year-old librarian discovered a comet. She promptly announced her discovery to her parents; Mr. Mitchell immediately posted a note to William Bond, director of the Harvard College Observatory. In 1831, the king of Denmark had offered a gold medal to the next person who discovered a comet with a telescope. (Comets were at that time generally discovered by eye.) Although the comet was also spotted in Europe, Mitchell's discovery was adjudged to be the first, and the medal was hers.

For the United States, Maria Mitchell became the symbol of women's emergence into the public world of science. In 1848 she became the first woman elected into the American Academy of Arts and Sciences—95 years were to go by until the next woman was admitted. And she was the active member of the American Association for the Advancement of Science. Nevertheless, when Joseph Henry, the first secretary of the Smithsonian Institution, announced in 1848 an “account of the new comet, the discovery of which is one of the first additions to science ever made in this country,” he never identified the “American lady” who made the discovery.

When Vassar Female College opened in 1865, Maria Mitchell was invited to become the director of the college observatory and professor of astronomy. She accepted the positions and remained at Vassar until her retirement in 1888. Like many other women professors then teaching in women's colleges, she had no college education, but she had developed her skills working at the Athenaeum and as “computer” for the United States Coast Survey, making calculations of planet and star positions from her home.

By the 1880s, more women were being hired as computers to do calculations and make measurements of photographic plates in observatories. A male graduate student of mine once quipped that American astronomy became preeminent over European astronomy because of two discoveries: Hale discovered money and Pickering discovered women.

George Ellery Hale, an eminent astronomer and organizational genius, learned how to raise money for building large, powerful telescopes by going to wealthy friends and others interested in revolutionizing American astronomy. Hale built the 40-inch refractor at Yerkes Observatory in Wisconsin, the 60- and 100-inch telescopes at Mt. Wilson in California, and the 200-inch telescope on Palomar Mountain in California. Though Hale's efforts helped put Americans at the forefront of astronomy, Hale harked back to the 19th century in his attitudes toward women. He and other astronomers dubbed the living quarters on Mt. Wilson (and later Palomar) The Monastery and banned women from using the telescopes—a restriction not lifted until the mid-1960s.



Some of the women who worked at Harvard College Observatory. From left to right: Ida Woods, Evelyn Leland, Florence Cushman, Grace Brooks, Mary Van, Henrietta Leavitt, Mollie O'Reilly, Mabel Gill, Alta Carpenter, Annie Jump Cannon, Dorothy Black, Arville Walker, Frank Hinkley, and Prof. Edward King.

Edward C. Pickering, as director of the Harvard College Observatory from 1877 to 1919, responded to the competitive forces in astronomy by combining observational astronomy and physics into a new technology—the field of astrophysics. Photographing the heavens each clear evening, astronomers used spectroscopy—examining the constituent wavelengths of the star’s light through a prism attached to a telescope—to distinguish between different types of stars. Pickering needed help to search the thousands of photographic plates his equipment was generating and to carry out long, detailed calculations to determine the positions and other information about those heavenly bodies recorded on the plates. Planning and directing the science was a man’s job; tedious detail work was considered suitable for women amateurs. While his style of doing astronomy opened the door for employing women, Pickering’s attitudes were nevertheless financially motivated. He learned that the women he hired were “capable of doing as much good routine work as astronomers who would receive much larger salaries. Three or four times as many assistants can thus be employed,” he reported in Harvard College Observatory’s annual report of 1898, “and the work done correspondingly increased for a given expenditure.”

Eminent women too shared the view that women were less suited for scientific tasks involving creative thinking. In 1893 physician Mary Putnam Jacobi sent a paper to the World’s Congress of Representative Women held in Bogota, Columbia: “Modern science,” she said, “requires a great number of assistants to perform manipulations involving much labor and time, requiring intelligence and great accuracy, but not necessitating original mental power... This is a most useful and important field of work for women.”

Of all the observatories hiring women, Harvard College Observatory hired the greatest number—a total of 45 during Pickering’s years as director. Along with Pickering’s new approach to astronomy, the establishment of the Henry Draper Memorial also contributed directly to this surge in jobs for women.

Henry Draper, a wealthy New York doctor and amateur astronomer, took the first photograph of the spectrum of a star in 1872. Spectral lines in stars—a series of dark lines appearing across a continuous band of color that corresponds to the radiation emitted by the star—had been observed through spectroscopes attached to telescopes since the early 1800s. Later, stars were classified into several types according to these spectral lines, which indicate the star’s various chemical elements. When Draper started photographing stellar spectra using a spectograph attached to the telescope, he could make a detailed photograph of the spectrum of a single star. With that innovation, the possibilities for studying the stars took a giant leap.

Historians have dubbed the women Pickering hired to perform such meticulous study “Pickering’s harem.” Modifying Draper’s technique they produced telescopic images of many stars, each spread out to form a spectrum, on a single photographic plate. Using a

magnifying glass, they studied the spectrum of each star in order to classify it. They recorded their observations, identified other heavenly bodies photographed with the stars, and checked the results with charts. Working with incredible patience and unflagging industry, they were observers, computers, and discoverers. Some became full-fledged mathematical astronomers, computing orbits of planets and asteroids. Some compiled star catalogs, devising systems to estimate stellar brightness. Some, like Williamina Fleming, were put in charge of managing the staff and hiring other women assistants.

An entry from Williamina Fleming's diary, dated March 12, 1900, tells something of her attitudes toward Pickering's policies on promotions and raises:



Williamina Fleming (standing).

“During the morning’s work on correspondence etc. I had some conversations with the Director regarding women’s salaries. He seems to think that no work is too much or too hard for me, no matter what the responsibility or how long the hours. But let me raise the question of salary and I am immediately told that I receive an excellent salary as women’s salaries stand... Sometimes I feel tempted to give up and let him try some one else, or some of the men to do my work, in order to have him find out what he is getting for \$1,500 a year from me, compared with \$2,500 for some of the other assistants. Does he ever think that I have a...family to take care of as well as the men? But I suppose that a woman has no claim to such comforts. And this is considered an enlightened age!”

Many of the women working at the Harvard Observatory were outstanding. Annie Jump Cannon established the system with which she classified the spectra of more than 350,000 stars. Cannon would examine the plate with a magnifying lens, mentally classify the star into a number of alphabetical categories depending on the pattern of lines she saw, and call out her identification to an assistant, who would write them down. She learned to identify the line patterns almost instantaneously, at a rate of more than three stars a minute. Arranging the spectral types of stars in order of the decreasing temperature, she originated an alphabetical sequence that was ultimately rearranged into the hottest to coolest sequence O, B, A, F, G, K, M—the Oh Be A Fine Girl Kiss Me sequence that every beginning astronomy student today must learn. The results of her classifications are published in a work named, ironically, *The Henry Draper Catalogue*. This compilation laid the ground for modern stellar spectroscopy.



Annie Jump Cannon at her desk.

In 1925, Cannon received, among other honors, the first honorary degree Oxford University ever bestowed on a woman. But through four decades of work at the observatory, she received no academic recognition from Harvard. Not until 1938, shortly before her death, was she made a professor of astronomy. As early as 1911, a visiting committee of the observatory reported: “It is an anomaly that, though she is recognized the world over as the greatest living expert in this line of work...she holds no official position in the university.”



Henrietta Swan Leavitt joined the observatory staff permanently in 1902. In 1910 she made perhaps that greatest discovery of the Harvard women of this era. She identified the Cepheids—stars in the Magellanic Clouds whose brightnesses vary. In so doing, she discovered that the period of a star’s variability was related to the star’s intrinsic brightness. The longer the cycle from faint to bright to faint, the truly brighter the star. This discovery evolved into the most funda-

mental method of calculating distances in the universe: by observing the period of variability of stars in other galaxies and thus obtaining their true brightness to compare with their apparent brightness. This made it possible for Edwin Hubble to later demonstrate that our galaxy is only one of billions in the universe. Obtaining distances to other galaxies by this method will be one of the prime tasks of the Hubble Space telescope.

However, Leavitt was not permitted to pursue her discovery; her job was to identify and catalog the variables. Pickering also assigned her to the difficult job of comparing color indices and magnitudes on plates from different telescopes. According to Cecilia Payne-Gaposchkin, another of the eminent women astronomers who came later to the observatory, this was a “harsh decision, which probably set back the study of variable stars for several decades, and condemned a brilliant woman to uncongenial work.” She died at a young age, before Professor Mittag-Leffler of the Swedish Academy of Sciences could nominate her for the Nobel Prize he thought she deserved.

By 1920, American women could study science, though generally only in women’s colleges; a few could get graduate degrees; and a dozen or so women had earned PhDs in astronomy. But the belief persisted that the role of women in doing science was different from the role of men. In a graduation address delivered to the 1921 class of Bryn Mawr College, Simon Flexner, Director of laboratories at the Rockefeller Institute, discussed “The Scientific Career for Women.” He distinguished discoveries based on “genius” or “imaginative insight”—and here the scientists he mentioned were men—from the predictable discovery demanding “knowledge, often deep and precise, and method, but not the highest talent.” Here his example was Madame Curie.

Cecilia Payne-Gaposchkin received in 1925 the first PhD in astronomy Harvard granted. Her thesis on stellar atmospheres was described by Otto Struve, an eminent astronomer at Yerkes Observatory at the time, as “undoubtedly the most brilliant PhD thesis ever written in astronomy.” She chose to remain at Harvard, since few other positions were available to her. But her career there was orchestrated by the observatory directors. She virtually never obtained the freedom to choose her own research directions, and her achievements were less remarkable than they might have been. For most of her professional career she remained untenured. Like Cannon, she was made a professor of astronomy and granted tenure at the end of her career.

Late in her life, and early in my career, I attended an international astronomy meeting at the National Academy of Sciences at which she was present, and one evening found myself helping her fix her zipper in the ladies’ room. Impulsively I took the opportu-



Cecilia Payne-Capochkin

nity to ask her many questions concerning her experience as a woman in a scientific field dominated by men. Oh, no, she replied to each of my questions, being a woman had made no difference.

But the next evening she sought me out as we were socializing in the Great Hall before the banquet. “You know those questions you asked me last night?” she asked. “Well, I decided that I gave you all the wrong answers.” Then she proceeded to describe many of the difficulties that had plagued her throughout her career at Harvard. Her autobiography, *The Dyer’s Hand*, published after her death, tells a tale of disappointment after disappointment, of opportunities denied. One of the most brilliant astronomers of her time, Payne-Gaposchkin was never permitted to work on astronomy’s significant problems and never elected to the National Academy of Sciences.

By 1950, women astronomers with PhDs from American universities numbered about 50 in a total community of about 300. Almost all of them were employed by women’s colleges; a few had access to other opportunities through a father, uncle, or brother who could sponsor them in the world of science. Almost all were single. They could look back on one hundred years of American women doing astronomy and note that limited opportunities had generally restricted the contributions women had made. They could not know that as a total percentage of the astronomy community their numbers would soon begin to shrink. At the founding of the American Astronomical Society in the 1890s, the eleven female charter members constituted about ten percent of the society. By 1895 women members numbered about 300 out of 4,000—about seven percent.

Since the 1950s, opportunities for women in astronomy have increased but serious problems have not disappeared. Women whose brilliance is apparent at an early age can study at prestigious undergraduate universities, be accepted to graduate schools, accomplish important research, and obtain university or observatory positions.

In spite of difficulties that still exist to this day, women are still becoming astronomers—and successful ones. They are asking important, imaginative questions about the universe and getting answers no less often than their male colleagues. In 1986, it had only been about 20 years that women were permitted to apply for telescope time on all telescopes—time being allotted on the basis of the excellence of the proposal.

Yes, times have changed. Seventeen years have passed since our first Women in Astronomy meeting and since then the gradients are positive. The fraction of women getting astronomy degrees has increased, and should soon approach fifty percent. The fraction of women in postdoctoral and in entry academic positions are also significantly higher. But women remain scarce at moderate and high level academic positions, and women of color are grossly underrepresented at all levels. Our aim in the future is to make opportunities in astronomy available to all.

I would like to end with the same paragraph I closed my article in 1986 for Science magazine. A cable was sent to me in 1978 that read:

“Dear Madame, You might appreciate hearing that four women astronomers are observing on Cerro Tololo tonight, on the four largest telescopes! We are M.H. Ulrich, M.T. Ruiz, P. Lugger and L. Schweizer.”

I hope the sky was clear that night.

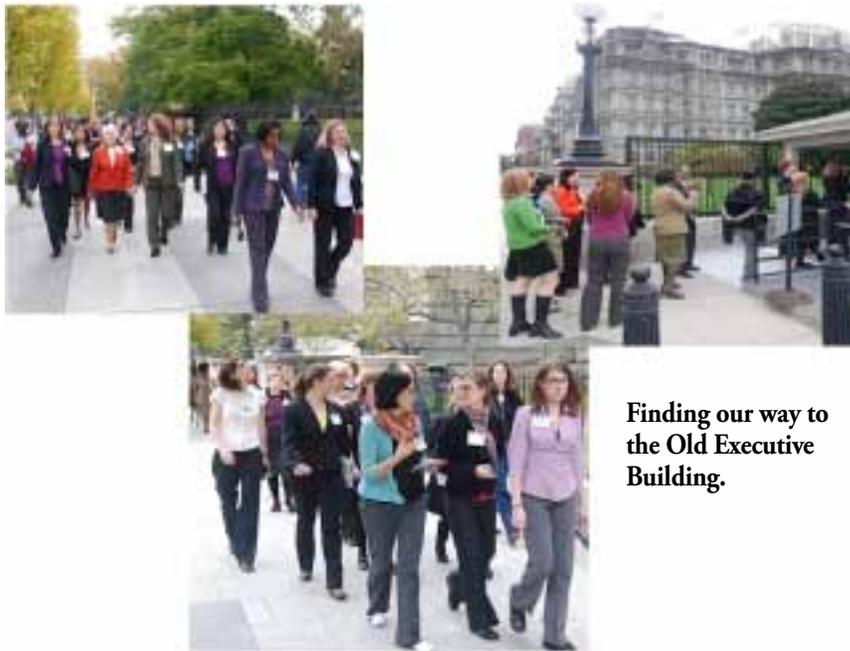


October 12, 1985, Las Campanas, console room of the 2.5 meter du Pont telescope. From left: Renee Kraan-Korteweg (University of Basel); Deidre Hunter, Vera (DTM); Wendy Freedman (OCIW), Anja Schroeder (University of Basel).

IX. WHITE HOUSE MEETING WITH
TINA TCHEN



Group photo of the WIA III 2009 White House tour attendees.



Finding our way to the Old Executive Building.



Our hosts Tina Tchen and Sarah Johnson.



Meeting room during talk.



Hannah Jang-Condell, pictured center, spoke first about the concerns of early career women scientists.

Women in Astronomy and Space Science: The Concerns of Early Career Women Scientists

Presented to **Christina Tchen**, Director of the White House Office of Public Engagement and Executive Director of the White House Council on Women and Girls & **Sarah Stewart Johnson**, White House Fellow at the Office of Science and Technology Policy on October 23, 2009

Hannah Jang-Condell, University of Maryland & NASA's Goddard Space Flight Center
Kerri Cahoy, NASA Ames Research Center; **Bethany Cobb**, University of California, Berkeley;
Meredith Danowski, Boston University; **Laura Lopez**, University of California, Santa Cruz;
Chanda Prescod-Weinstein, Perimeter Institute for Theoretical Physics, **Angie Wolfgang**,
 University of California, Santa Cruz

FOREWORD

As part of the Conference on "Women in Astronomy and Space Sciences" a group of conference participants were invited to attend a tour of the White House and have the opportunity to meet with Tina Tchen, the Director of the White House Office of Public Engagement and Executive Director of the White House Council on Women and Girls, and Sarah Stewart Johnson, White House Fellow at the Office of Science and Technology Policy. Those of us who were early career scientists (graduate students or postdocs) met over lunch prior to the White House tour to discuss what our biggest concerns were and how the White House could help us address those concerns. We formulated our statements and read them to Ms. Tchen and Ms. Stewart at our meeting. This paper is the presentation we gave.

1. INTRODUCTION

As early-career women in astronomy, our group was able to identify six major themes that concern us. The first is the long career path to becoming a professional astronomer, which

requires perhaps 5-7 years of graduate school, plus a similar length of time as a postdoctoral researcher (“postdoc”). During this time, encompassing our twenties to early thirties, we are seldom considered full-time employees of our institutions, despite the fact that we are working full time.

This leads into the next two issues that concern us: health care and parental leave policies. Our concerns about health care include domestic partner benefits, dependent care, and coverage in the event of pregnancy. Parental leave policies are of concern because graduate students and postdocs are often not considered to be employees, but fellows with stipends; therefore we are not covered by the Family and Medical Leave Act (FMLA). Child care is also an issue that affects many of us. In both health care and parental leave, the U.S. falls far short of the coverage that exists in virtually all other industrialized nations. The resolution of these issues can directly benefit us as women in astronomy.

A fourth issue is that women still face bias, despite existing laws meant to guard against most forms of discrimination. Women’s job performances are often evaluated as inferior to that of men’s, despite equal or superior accomplishments. Minority women also face additional implicit biases. The existence of implicit bias needs to be recognized and ways of fighting it must be developed.

The last two issues deal with education and public outreach (E/PO), and mentoring. E/PO is important for keeping children interested in science starting from a young age. At every step along the scientific career pathway, from the student to the faculty level, mentoring, particularly from individuals who look similar to ourselves is important. Federal granting agencies should actively support and incentivize mentoring activities. It is also important for the work of E/PO and mentoring to be valued and rewarded within our professional circles.

2. CAREER TRAJECTORIES FOR WOMEN IN ASTRONOMY AND SPACE SCIENCE

There is an enormous difference between the ways young academic scientists are regarded compared to our peers who take jobs after college. Our peers are treated as professionals and have access to benefits and support structures. Meanwhile, we are working as scientific researchers as graduate students or as postdocs. Despite our considerable skills and the difficult tasks that we take on, we scientists are still treated as students.

Graduate school takes 5-6 years. Postdocs take 2-3 years each, and we typically do multiple postdocs before landing a permanent position. In other words, we spend our twenties and early thirties (prime childbearing years) frequently changing jobs and often having to move multiple times. The graduate and postdoctoral research trajectories introduce a series of

unavoidable short-term transitions at a point in life when many women need stable employment and health insurance in order to support family life. Also, statistics show that many female scientists have spouses who are also in academic research, which compounds the income and childcare issue. Male scientists are currently less likely than female scientists to have a spouse in academic research, which often helps mitigate the income or childcare challenge.

- We need to make sure early-career women in science are fairly compensated and respected for their skills.
- We need to provide income and health insurance stability for early-career women in science as they navigate the graduate and postdoctoral transitions.
- We need generous family leave policies and affordable childcare to enable early-career women to maintain their jobs while growing their families.

3. HEALTH CARE

Comprehensive and affordable health insurance coverage is not always available to early-career scientists. This situation can unduly burden both graduate students and postdoctoral scholars—while postdocs are not students, they are also not treated as true employees by many academic institutions. Healthcare represents just one more source of worry for young scientists who are already confronting the stress of temporary and uncertain employment during their early careers. This situation is particularly difficult for young scientists facing the healthcare costs associated with beginning (or expanding) a family. Concern over healthcare costs may also discourage young scientists from pursuing non-standard but important careers in science, including professions that focus on public outreach, teaching and/or public policy. In order to attract and retain the next generation of scientists, particularly women, minorities and students from disadvantaged backgrounds, healthcare must be made affordable and accessible for all young scientists.

4. FAMILY LEAVE POLICIES

As young scientists, we have a growing concern about causes for attrition in our discipline. One of the possible reasons for the loss of young female scientists is the lack of a well-developed and comprehensive family leave policy across all workforce levels. Grant-supported young scientists such as graduate students and postdoctoral scientists are particularly vulnerable because they are not protected from pregnancy discrimination. The Family and Medical Leave Act (FMLA) does not apply to graduate students and postdocs and granting agencies do not have policies to support researchers who take leaves of absence for family or medical reasons. For example, a postdoctoral fellow in her 20's or 30's may become pregnant. Depending on her advisor, institution, or funding agency, she may

be granted leave, but it will likely be unpaid and possibly without insurance, or she may even be asked to leave her research position. The existence of policies for graduate students, postdoctoral researchers, research scientists and faculty alike would assist the cause of science by allowing us young scientists to simultaneously pursue science and support our families. Such policies would greatly help us through the difficult and poorly timed transitions in our careers.

Our opinion, supported by recent data from The Shriver Report, is that addressing the issue of both parental leave and family care policies on the national level would greatly benefit astronomy by attracting and retaining the best scientific talent. (The Shriver Report: A Women's Nation Changes Everything, Heather Bousley and Ann O'Leary, eds., October 2009. www.americanprogress.org/issues/2009/10/pdf/awn/a_womans_nation.pdf). The current administration can help affect this change by becoming a model institution as well as incentivizing programs for universities, national labs, and other scientific facilities. We also recommend that federal grant agencies (e.g. NSF, NASA) proactively implement funding policies for family and medical leave.

5. CONSCIOUS AND UNCONSCIOUS BIAS

Conscious and unconscious biases are still prevalent in the hiring, assessment, and promotion of individuals in the scientific work force. Many studies demonstrate that stereotypes and expectations of a group influence how they will be judged. For example, in a study on evaluation of identical application packages, universities preferred to hire “Brian” two-to-one over “Karen” for professorships. Another study, involving identical resumes submitted for business jobs, showed “Brads” were called back twice as much as “Hakeems,” regardless of the job. People hold these stereotypes, regardless of which group they themselves belong to, and they are not necessarily aware of these biases. One instance of this may seem small, but summed together amounts to a substantial and self-sustaining disparity.

Fortunately, several practices have been shown to help alleviate this problem:

- Awareness: Knowing that there is a problem is the first step; let people know they are unconsciously overlooking talent. (See Abigail Stewart's paper in this publication, “Addressing Unconscious Bias”).
- Practices, especially pertaining to job candidate evaluation and recruitment: Increased documentation and knowledge of individuals decreases use of stereotypes, so candidates should be evaluated based on several criteria instead of global judgments. It also helps to increase the pool of individuals from a given group, so stereotypes are not useful in evaluation.
- Policies: Require annual reviews to assess how practices are working and require evaluating committees to be diverse.
- Accountability: Give rewards for successful practices and disincentives for maintaining the status quo.

6. EDUCATION AND PUBLIC OUTREACH

Based on studies such as the National Research Council's January 2009 report, *Learning Science in Informal Environments: People, Places, and Pursuits*, informal education and public outreach can play a major role in inspiring young girls to pursue science. However, there are a number of issues, some of which are outlined below, that reduce the effectiveness of informal education. Here we suggest some policies that the White House could advocate to address these issues:

1) Many parents do not or cannot make informal science education a priority for their young girls due to misinformation, antiquated perceptions, and/or limited resources.

Action: Launch an education campaign similar to the Harlem Children's Zone that empowers parents to empower their children and impresses upon them the value of a scientific education for both genders.

2) Not all families can access or afford to attend science museums and/or informal science education programs.

Action: Subsidize science museum construction and admission, especially in inner city areas, or give tax breaks to the organizations that do. Stipulate that a portion of these exhibits/educational programs explain the science done by women in a wide range of scientific disciplines so that the young girls who attend these programs can find a variety of role models who "look like them" and do science.

3) Many girls learn through social cues that science is "for boys." This realization, reinforced by authority figures, peers, and the media, can conflict with their developing gendered self-perception and lead to decreased interest in science.

Action: Enforce schools' continual assessment of their Title IX compliance with respect to science education and reward those schools that exhibit equal male-female enrollment in science courses.

4) There is a disconnect between the enthusiasm for science discovery inspired by informal education outside the classroom and the "boring" view of science received inside the classroom.

Action: Include inquiry-based science skills on equal footing with reading, writing, and math skills in the "No Child Left Behind" exams. The inclusion of discovery-based science on national standardized tests will incentivize teachers to spend more time on science labs where students get hands-on experience in science.

We also wish to bring to the White House's attention an issue that has arisen in informal education and public outreach which directly affects us as early-career scientists: **due to the high demand for female role models, many professional women scientists are expected to do more outreach than their male counterparts. Unfortunately, this time commitment interferes with their research productivity and puts them at a disadvan-**

tage in their scientific field compared to their male colleagues. This issue motivates the evaluation of existing informal educational programs and how efficiently they use the time volunteered by female scientists. Nevertheless, we encourage the White House to continue to hold pro-science events that have diverse scientists in attendance, such as the recent star party on the South Lawn. The high publicity of these events can slowly but noticeably change the public perception of the white male scientist as “typical.”

7. MENTORING

When we talk about changing the face of astronomy or physics, it is crucial that we talk about mentoring. This is true for all future astronomers and physicists, and studies show that it is particularly important for white women and all scholars from underrepresented minority groups. Hands-on and one-on-one mentoring brought all of us to our current scientific positions, and multiple studies indicate that mentoring is crucial for our career development. Enhancing mentoring is a straightforward way to enhance diversity.

Luckily, we have a wealth of homegrown intelligence about how to successfully mentor and support diversity. Minority-serving institutions (MSIs), particularly Historically Black Colleges and Universities (HBCUs), are great successes! The top eight producers of Black PhDs in STEM careers, for example, are all HBCUs. Therefore:

- We must continue to help HBCUs and other MSIs do the work they do so well by helping to ensure that their science programs continue to grow.
- We must learn how to do adapt their practices and bring them into the majority institution setting. This effort can be enhanced by the development of Bridge programs, like the Fisk-Vanderbilt partnership, Columbia University Bridge to PhD program, and one currently in development at MIT Physics.

8. CONCLUSION

The concerns of early career women astronomers are not necessarily much different from average Americans. As I am writing this, landmark health care legislation is finally being signed into law. Family-friendly policies are highlighted in the Shriver Report (“A Woman’s Nation Changes Everything”) as being crucial to working families across the country. The Obama administration has launched the “Educate to Innovate” campaign to encourage more students to study STEM fields. The National Science Foundation (NSF) has recognized the importance of mentoring by now requiring postdoc mentoring plans on all grant proposals. These are all steps in the right direction, and the effort to implement them all in full must be continued and sustained. Moreover, these initiatives do not necessarily address the underlying problem of the length of the postdoctoral period, nor do they directly address the problem of unconscious bias. Still, our discussions with Ms. Tchen and Dr. Stewart Johnson gave us great hope for the future.

X. NETWORKING EVENTS AND CAREER
WORKSHOP

Networking Breakfasts

The networking breakfasts were set up and designed to give early career attendees of the WIA III 2009 the opportunity to speak with established and experienced scientists. Forty-three meeting attendees quickly signed up for a spot with one of our participating senior scientists—many attended all three days.

The meetings were casual; fashioned as a round-table discussion with one or two later career scientists having breakfast with about ten participants who posed questions and asked advice. The three meetings proved to be extremely successful. It put our attendees at ease, opened dialogue, and allowed them to make connections and friends with other members of the conference. Most important, these networking breakfasts made for an atmosphere of camaraderie at the conference. It allowed our attending junior scientists to associate with those who are more senior as peers and address issues that concern all scientists, both junior and senior.

SENIOR PARTICIPATING SCIENTISTS

Wed. Oct. 21, '09	Thurs. Oct. 22, '09	Fri. Oct. 23, '09
Meg Urry	Mark Sykes	Barbara Williams
Debra Elmegreen	Kathie Olsen	Fran Bagenal
Ed Weiler	Kivan Stassun	Laurie Leshin
Colleen Hartman		

EARLY- AND MID-CAREER PARTICIPANTS:

Kate Brutlag	Meredith Danowski	Emily Freeland
Erin Zekis	Bethany Cobb	Gwinne Crowder
Stacy Teng	Carie Cardamone	Laura Trouille
Jennifer Andrews	Brittany Kamai	Yilen Gomez Maqueo Chew
Delphine Perrodin	Katherine Gietzen	Katherine Schlesinger
Nia Imara	Queyn Hart	Jennifer Yee
Abigail Crites	Katey Alatalo	Chantale Damas
Alyssa Gilbert	Therese Jones	Sonali Shukla
Ashley Pagnotta	Angie Wolfgang	Andrea Urban
Natalie Gosnell	Jennifer Piscinore	Claudia Knez
Jamie Lomax	Maria Patterson	

COMMENTS ON NETWORKING BREAKFASTS

I had the privilege of attending all three of the networking breakfasts at WIA III 2009. I sat with Debbie Elmegreen, Keivan Stassun, and Laurie Leshin. The conversations were always enjoyable and informative. Even though most of the attendees were at a similar stage in their careers, we each had different experiences to share.

I heard from women who have started Women in Science groups in their departments in response to a culture of sexism, which was very interesting. I got practical advice from women who successfully earned some of the postdoc fellowships I plan on pursuing. I got to share the details of a wonderful seminar I took on how to get a job in physics that covered both academic positions and the “alternative” careers that many of us will end up choosing.

Having the chance to interact with the VIP guests was very enlightening. Debbie Elmegreen was genuinely concerned about our views on the current culture in astronomy, and how we see our futures. She was somewhat surprised by the fact that most of us plan to pursue careers that do not fall along the typical “tenure track professorship at a major research university” path. Keivan Stassun shared his unique experiences, including the efforts he’s made in education and public outreach, both as a graduate student (particularly timely for us!) and now as a professor. His description of the faculty position negotiation process and his offer to be a resource for us in the future were both very much appreciated.

It was a pleasure to meet Laurie Leshin, and I was not disappointed. I’ve wanted to work for NASA for as long as I can remember; a job like hers is particularly interesting to me. She described her career path and the impact it has had on her family-life, which is an aspect usually missing from official biographies, and only available at events like these.

In all, I’m very glad I attended the networking breakfasts. It was a great opportunity to make stronger connections with other early-career women and to hear from experienced astronomers about the challenges they faced, how they overcame them, and what they see happening in the community in the future.

*Dr. Ashley Pagnotta
Louisiana State University*

During a bright and early breakfast meeting, we met with a group of astronomers and scientists to discuss career opportunities, to try to give advice, and to share observations about the field of science. During a “career session,” most of the participants expected to hear that we both had devised an early, pointed, and clear path to jobs as Associate Administrator or Deputy Associate Administrator. This belief is most prominent among those new PhDs as they stand on the threshold of what is sometimes called “real life.”

Yet, we had something a bit unusual to say; neither of our career paths was by design. Instead, working hard at whatever tasks presented themselves and constantly reassessing what we enjoyed most in astrophysics resulted in a management career. A career in the federal government is most satisfying if one’s aim is to further science on a national and international scale and a career in academia or industry is no less satisfying with the thrill of producing new research results. Both are exciting and both are rewarding in different ways.

Of course, it isn’t all work. A most important part of any career and one that may be too often overlooked is the friends one makes. Many of the people organizing and sharing at this conference are bound to each other by enormous affection and by shared experience of a time that may never come again.

The enthusiasm and motivation evident in this group of women is proof that science and her practitioners will continue to lead future generations in the United States. We want to thank the participants at the breakfast because having the opportunity to listen to them was, most of all, a gift to us.

*Dr. Colleen Hartman and Dr. Ed Weiler
NASA*

(Editor’s note: Dr. Ed Weiler has been AA at NASA for eight years and Dr. Colleen Hartman has been Deputy AA at NASA and NOAA, as well as acting AA at NASA.)

The networking breakfast was a wonderful success, and I was delighted to participate. I sat at a table with about ten graduate students, whose questions centered primarily on the types of jobs available after the PhD, and how to blend family life with astronomy. We discussed the kinds of training and mentoring they were receiving. The students were curious to hear my perspective from 30 years past graduate school, and some of the older students also had good advice based on their newer perspectives to share with the younger ones.

I think what made the event so successful was that the breakfast provided an excuse for people to gather together comfortably, with time to chat and explore different issues, in a way that's not possible over a brief coffee hello or a poster greeting. They requested that the AAS try to have some mentoring activities like this (AAS has done so in the past, with mixed success) since they felt it opened a convenient path for them to meet with senior astronomers. I think this experience is also good for departments to consider; my department tries to have a women's faculty/student lunch every few months, to hear student concerns and offer advice.

*Dr. Debra Elmegreen
Maria Mitchell Professor of Astronomy and
Chair, Department of Physics and Astronomy, Vassar College*

One of the issues that I noticed at the WIA conference (and was discussed at the breakfasts) was that of job security. It seems that while everyone likes the idea of a tenured faculty position, many women at the meeting expressed concerns about the academic track with five years of post-doc plus seven years to tenure, feeling that was just too long to wait before having a secure position. While some people (e.g. myself) liked and benefitted from working at different institutions across the globe, I understand that this is a real concern for many people, particularly women who are affected by the two-body-problem and family commitments. I am not so sure that this academic apprenticeship is that much longer than other professional fields, but even a perception of excessive duration needs to be addressed.

First, it would be useful for the professional societies (AAS, AGU, etc) to evaluate the demographics of our profession. We should not be guessing what fractions of PhDs take different paths. I expect that the AAS/CSWA longitudinal study will be very useful in this respect, as will be the AIP study of planetary sciences. Second, we need information and advice on the range of careers within our profession, not just the academic track. Third, the universities need to evaluate the academic career track to assess if they are able to hire the people we would all want to be training the next generation, or are such people being attracted to what is perceived to provide a more secure position earlier in their career (e.g. government labs, industry, elsewhere?).

*Dr. Fran Bagenal
Professor of Astrophysical and Planetary Sciences &
Laboratory for Atmospheric and Space Physics, University of Colorado*

Seven AM, October 21, 2009. Bleary eyed and tired, I drove to the University of Maryland Conference Center, found the breakfast room, and sat down at my table. An hour later, even drinking decaf, I was totally energized by the enthusiasm and engagement of the young women astronomers at my table. They were excited to be at the Women in Astronomy meeting and eager to talk about the demographics in our field. In fact, the meeting organizers had to pry us out of the room when the conference proper was due to start.

We talked about a lot of things that morning but the topic I remember best is how today's young women differ from my generation or the intervening generation. Many of us who got our PhDs in the 1980s expected gender equality in our chosen profession—we expected to be judged on the merits—and when we saw our male peers advancing faster and higher, we tried to understand what was happening. We organized the first Women in Astronomy meeting, in 1992, in Baltimore, wrote the Baltimore Charter, and were active in the AAS Committee on the Status of Women in Astronomy, as had been the cohort a decade before us (although we had to experience problems first-hand before we joined them). In contrast, the women who got their PhDs in the 1990s seemed less likely to take the activist path and less likely to try to fix the system; instead, they seemed to frame their experience and career decisions in very personal terms. Now, at breakfast, I was meeting some of the next generation, women who were still in graduate school or who had gotten their PhDs since 2000.

Much like us and unlike the intervening generation, these women seemed primed for action on behalf of other women. In part this was obviously a selection effect: who else attends Women in Astronomy meetings, and moreover, who gets up extra early in order to come to breakfast at seven in the morning? Still, there was agreement on the very real differences between generations. We discussed several possible explanations. Of course, we don't even have solid evidence of the trend, much less know its cause, but here is logic of the most plausible explanation we came up with: First, it is true that women in all three generations (80s, 90s, 00s) expect, as a basic right, equality of opportunity and outcome. Second, women in the 80s were outraged when we slowly realized this promise didn't hold true, so we agitated for change. Third, things (climate, opportunities, rewards) got better, so women in the 90s didn't necessarily see that there were still battles to fight. Instead, they imagined that whatever obstacles they encountered, such as the difficulty of balancing career and family, resulted from their personal circumstances, and thus the solutions were also personal. Fourth and finally, the young women rising in the 00s have seen enough to recognize the institutional nature of the barriers to women, and they are ready to address the root causes, hence the re-rise in activism.

I hope our impression of the generational shift is correct. I hope the young women I met at breakfast will plow through, so that gender imbalance and the lack of minorities in astronomy and astrophysics is soon a thing of the past that none of us need to worry about. We will all celebrate that day.

*Dr. Meg Urry
Professor of Physics
Chairman, Department of Physics, Yale University
Director of the Yale Center for Astronomy & Physics*

Evening Social

As the registrants streamed in on the first morning of the conference their welcome package included an address book of all the attendees. The book that included a space next to each name was meant to encourage conference participants to network.



Anne Hornschemeier explaining the networking booklet to the audience.



SIGNATURES, SMILES...

During the conference, participants were encouraged to introduce themselves to those they did not know and exchange autographs. The goal was to gather more than fifteen signatures in order to be entered to win prizes awarded at dinner the following evening.



...AND MORE SIGNATURES



Many attending the conference satisfied the fifteen-signature requirement for the raffle, had the opportunity to meet people from outside of their immediate network, and make valuable connections—both professional and personal.



...AND THE WINNER IS...

COACh Career Workshop

THE WORKSHOP AT THE WIA III 2009

The 2009 Women in Astronomy conference organizing committee felt that it was important to include a workshop that would focus on negotiating and problem solving skills. The committee elected to hold the workshop on the day previous to the actual conference start-date. Some very hard work went into organizing this workshop. Hannah Jang-Condell (UMD and NASA/GSFC), who initiated the idea of having the workshop, was chosen to be the coordinator. Phone calls, emails and many meetings later we had a workshop!

Next we needed to open up registration. It was at this point that the WIA 2009 committee came to a disagreement. We knew that the workshop was meant mainly for women but many of the committee members felt it unfair if we did not open registration to males. Others thought it would not be inappropriate to have just whom the workshop was originally created for—women. Again, meetings, phone calls and emails. After much negotiating, we decided that in the spirit of the conference (inclusion was one of the major topics) men should not be excluded. Registration quickly filled to capacity and we had two brave men who signed up for the workshop. We not only had attendees who were at the beginning of their professional careers but also senior scientists and even one of our presenters, Rachel Ivie. Since networking is an important part of the scientist's career, and highly encouraged in this seminar, the organizing committee realized that the diversity of its attendees would be a major bonus for all participants of the workshop.

Basic Negotiation, Problem Solving and Conflict Resolution is a four hour interactive seminar taught by Ernestine Baker and Jane Tucker (for biographies please see the Women in Astronomy 2009 web site). The workshop is meant for 20 to 24 people, but because of time constraints, we asked the facilitators if they would be willing to teach as many as 40 in one session. Ernestine and Jane, being the professionals they are, understood and quickly agreed.

BACKGROUND

The COACh (Committee on the Advancement of Women Chemists) program was founded in 1999 by Dr. Geraldine Richmond, a chemist from the University of Oregon. Dr. Richmond invited senior faculty members in the chemical sciences from throughout the United States to join the program and sit on the advising committee. COACh plans and implements a number of programs that include professional skills development workshops for faculty, research on gender issues in the chemical sciences,

development of a data base of women in the chemical sciences, and coaching, mentoring and networking activities at all levels.

The COACH members realized that the recruitment and retention of women and underrepresented minorities such as Hispanics and African Americans is an important factor in increasing our global visibility in the fields of science. These untapped groups can increase productivity and innovation.

At the outset, the COACH programs focused on female chemists and their concerns about the gender-based obstacles they face in trying to attain their career goals. The program has now expanded and participants in the seminars have come from all STEM fields and medicine.

WHAT THE COURSE OFFERS

The course description is as follows:

Basic Negotiations, Problem Solving and Conflict Resolution (Half Day)

This seminar is designed to build understanding of mutual interest based negotiations or solution finding. The content encourages:

- developing understanding of the parties' interests;
- clearly asking for what you want;
- developing alternatives that enhance the possibility of reaching agreement;
- packaging of the possibilities, and
- introduces the notion of anchoring and a zone of possible agreement.

Sometimes, no matter how hard one tries, an agreement is not achieved. In this case, participants will learn to develop and consider using a BATNA or the "best alternative to a negotiated agreement" before they start to negotiate.

Participants will evaluate their personal conflict resolution styles. Case studies will reinforce the use of effective styles in negotiating and problem solving. Case practice includes various topics, such as a competitive job offer, committee service, salary increase and research resources. These cases help define patterns of negotiations when choice and stress are factors. Development of supporting data, options and packaging solutions are examined relative to these cases.

Participants are introduced to a negotiations planning worksheet to be used in preparation for negotiations. If time permits, attendees practice their own cases and receive coaching feedback. Several methods of responding to difficult tactics are demonstrated and discussed. (©2008 Humaned & Jane Tucker & Associates. No part of the above course description may be used without the express permission of the author)

The negotiating strategies include case studies, pragmatic learning content and actual issues facing the attendees. The communication techniques section is devoted to strategic management of discussions and negotiations, teaches techniques to enhance performance and uses role-plays. (J.Greene et al.)

As an example, a section of the seminar is devoted to teaching the attendees how to handle dealing with different personality behaviors:

The Sherman Tank—abrupt and intimidating

The Wet Blanket—counters ideas and tends to see the negative side

The Bulldozer—the know-it-all expert

The workshop attendees are encouraged to use their own case scenarios to learn better negotiation strategies and communication techniques.

PARTICIPANT REACTIONS

The COACH seminars have been attended by over 2,500 individuals over the years. After the workshop at the WIA III, Dr. Rachel Ivie, a Sociologist, wrote: “The presenters were very well-prepared. The workshop got me thinking about steps to take to move forward in my career.”

Dr. Lucy McFadden an attendee of the workshop and a research professor at the University of Maryland at the time of the conference wrote:

“I found the career workshop very useful. Since then, I have searched for and taken a new job. I put the material presented at the workshop to work and it paid off. Furthermore, I find myself passing on the advice from the workshop to others. Basically, determine what you are looking for, what is important to you, and be sure to ask for it. It is the asking that is important. You owe it to yourself to ask. Of course, one has to be prepared for alternatives; if you don't get what you ask for, then what? Think through the options ahead of time.”

Dr. Nelly Mouawad, of the University of Maryland, who earned her PhD in 2005, sent in the following:

During the Career Workshop, I was presented with ideas and approaches that I hadn't thought of before. One point on which there was a huge emphasis, and that I took away, is the practice and preparation of a negotiation plan before a meeting. Normally, given the way we escalate the steps of our academic life, most of us are in situations where we don't negotiate; we accept offers without even wondering if negotiation is possible. This habit starts early on (at least in my case), when we are accepted for a PhD position, and then a postdoc. So as we are getting ready to start

on an independent track, we are not used to or familiar with the grounds and style of negotiating a certain offer.

One important thing I got out of the workshop is that there is room for negotiation from the outset of one's career and we should not hesitate to express our demands. Mostly, I understood the importance of preparing a plan before a meeting, such as thinking of alternatives to a negotiated agreement and to consult with an expert before the meeting. Repeating one's viewpoint more than once to make it clear, and reiterating the issue to find a mid-way solution during a meeting are ideas I will remember after the workshop.

As a whole, the workshop has strengthened my confidence, and changed my perspective about some issues. I think when I will be in a situation of needing to negotiate, and because of the workshop, I won't be shy with my requests. In any business, each part sets his limits, and a mid-solution is found in between. It is not because we are in science and we love what we do, that we should not be well rewarded for it. It was also nice to share this experience with other fellows and seniors. We realized that we all share similar situations, and there are times when we will need to solve conflicts. Whether they are small or big, they are better solved if we start from common grounds and build on the positive side of things. The facilitators kept the atmosphere active, interactive and lively. It was a very informative and fun workshop, and I encourage others to take it if possible.

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XI. SUMMARY

Women in Astronomy 2009: Lessons and Outcomes Relevant to Underrepresented Minorities¹

Laura Lopez, University of California Santa Cruz

The Women in Astronomy and Space Sciences 2009 (WIA2009) conference was held at the University of Maryland, College Park, on October 21-23, 2009. The meeting was the third of its kind, following in the footsteps of “Women in Astronomy I” at the Space Telescope Science Institute in 1992 and “Women in Astronomy II: Ten Years After” at the California Institute of Technology in 2003. Broadly, this series of conferences has addressed issues pertaining to women in our field: demographics of the astronomy community, assessment of the climate toward underrepresented groups, and strategies to diversify our workforce.

The state of our profession has changed dramatically since the initial WIA meeting nearly eighteen years ago, and the tone of the meetings’ discussions has adapted accordingly. In 1992, the general astronomy community was not aware of (or ignored) the bleak status of women in the sciences, and WIA I culminated in the creation of the Baltimore Charter that outlined the problem and recommended solutions. By 2003, the community acknowledged generally that a problem existed, and WIA II explored the actions necessary to ameliorate the “leaky pipeline” at several levels. Their conclusions were presented in the Pasadena Recommendations, and six years later, the Pasadena Recommendations have been by many institutions. As a consequence, gender parity is beginning to occur at the undergraduate and graduate levels. In order to maintain this “leakless” pipeline such that it continues up to the senior scientist and faculty tracks, now is the time to consider the inclusiveness and environments of individual departments. It is this backdrop that motivated the presentations and discussions at the recent WIA2009 meeting.

Although the focus of the conference was topics relevant to women in astronomy, strategies to generate inclusiveness are important to increase diversity generally. Thus, many lessons regarding gender in our workforce can be extended to the case of underrepresented minorities (URMs) in the field as well. This article aims to summarize the talks from WIA2009 in the context of URMs.

STATISTICS

The conference began with presentations on the current demographics within astronomy and sciences generally. Dr. Rachel Ivie of the American Institute of Physics discussed an on-going longitudinal study of 800 junior AAS members (of whom 41% are female). Preliminary results show that women are more likely to suffer from “Imposter Syndrome”,

¹This article first appeared in the January 2010 issue of *Spectrum*.

the feeling that their academic success is not from genuine ability. Females who rated their departments as unwelcoming were more likely to exhibit signs of Imposter Syndrome, and those who felt mentored within their department were more confident in their research skills. In the future, the study will aim to show the relationship between these factors and attrition. While this work does not survey the racial/ethnic background of the individuals, it still demonstrates the critical role of mentorship and of a supportive climate in the early career of all scientists.

Next, Professor Claude Canizares of MIT presented the findings of the National Research Council investigation in 2004-2005 on the status of females in STEM faculties at 89 research universities. Although this study did not consider race/ethnicity either, some results pertaining to women extend to URM as well. For example, two-thirds of the departments said they took no or only one step to increase the gender diversity of their applicant pool. If these departments are not recruiting qualified females, it is unlikely they are doing equivalent efforts for URM candidates.

Although the AIP and NRC data painted a positive and improving picture for women at all levels, neither study surveyed the racial/ethnic background of the individuals in their samples. Without this information, it is uncertain whether minorities of either gender are increasingly represented as well. Similar studies (both longitudinal and snapshot) in nature and scope are necessary to assess the state of the URM pipeline.

UNCONSCIOUS BIASES

After opening with the demographics, the meeting shifted gears to address the conscious and unconscious biases that influence how individuals are evaluated. Professor Abigail Stewart of the University of Michigan summarized the studies that demonstrate how schemas, or stereotypes, affect hiring and assessment of credentials. In a study involving evaluation of identical application packages for assistant professor positions [1], male and female psychology faculty were twice as likely to hire “Brian” over “Karen”. When identical records were presented for tenure consideration, the faculty expressed reservations four times more often for “Karen” than for “Brian”.

Although they were not discussed at WIA2009, similar studies have been done using identical job applications with white- and black- sounding names. For example, one experiment sent nearly 5,000 identical resumes to job openings [2], and they found that “Brad” received almost twice as many call-backs as “Tyrone”, and “Brad” received five times as many call-backs as “Tamika”. Even when “Tyrone” and “Tamika” were given substantially better credentials, “Brad” was still called back at the same rate.

Evaluators rely on schemas because it allows efficient (albeit sometimes inaccurate) assessment of information. These biases tend to be applied more under circumstances of ambiguity (including insufficient information), time pressure, and a lack of critical mass within a group [3]. And although any one instance of reliance on stereotypes is minor, the accumulation of these imbalances can sum to significant disadvantages.

Fortunately, there are strategies that are effective at mitigating reliance on schemas. Broadly, these steps fall into four categories: awareness, practices, policies, and accountability. Once evaluators are aware of schemas and how they cause talent to be overlooked, they tend to weigh individuals more objectively.

Practices at several levels can alleviate reliance on schemas. One strategy is to change the way evaluations are given: specifically, decrease the ambiguity of selection criteria by rating specific characteristics of an application (e.g., scholarly productivity, funding, teaching ability). The University of Michigan offers an online “Candidate Evaluation Tool” to facilitate this process at: <http://www.umich.edu/%7Eadvproj/CandidateEvaluationTool.doc>.

Another critical practice is recruitment to increase representation in an applicant pool. Studies show a critical mass of individuals from a group causes evaluators to differentiate candidates and to rate these individuals more highly: a diverse applicant pool naturally encourages fair assessment. Stewart offered tips on diversifying applicant pools: recruit year round, solicit a wide range of institutions (including lower-ranked programs, since evaluator bias may cause well-qualified individuals to end up in less prestigious programs), and use of broad/open job searches instead of narrow ones. Broadly, good practices like these lead to good policies and to accountability. By monitoring and reviewing the above practices, a department/ institution can reinforce these positive efforts.

UNEARNED ADVANTAGES & DISADVANTAGES

If women and minorities are at a disadvantage because of their gender and race, then it implies that men and whites are at an advantage for their sex and skin color as well. Dr. Peggy McIntosh, the Associate Director of the Wellesley College Center for Research on Women, summarized her ground-breaking article, “White Privilege and Male Privilege: A Personal Account of Coming to See Correspondences through Work on Women’s Studies” at WIA2009. Dr. McIntosh articulated that men and whites have unearned privileges that are often unacknowledged and unnoticed in society. As such, these majority groups are taught to believe their lives are morally neutral, even though their actions implicitly confer dominance to their groups.

Dr. McIntosh has produced a list exemplifying the unearned privileges she experiences in her everyday life because of her skin color. Here are some of the items she identifies:

- *“When I am told about our national heritage or about civilization, I am shown that people of my color made it what it is.”*
- *“Whether I use checks, credit cards or cash, I can count on skin color not to work against the appearance of my financial reliability.”*
- *“I can swear, or dress in second-hand clothes, or not answer letters, without having people attribute these choices to the bad morals, the poverty, or the illiteracy of my race.”*
- *“I am never asked to speak for all the people of my racial group.”*
- *“If a traffic cop pulls me over or if the IRS audits my tax return, I can be sure I haven’t been singled out because of my race.”*
- *“I can easily buy posters, postcards, picture books, greeting cards, dolls, toys, and children’s magazines featuring people of my race.”*
- *“I can take a job with an affirmative action employer without having coworkers... suspect that I got it because of race.”*
- *“I can choose blemish cover or bandages in ‘flesh’ color and have them... match my skin.”*

Knowledge of the unearned advantages and disadvantages associated with race raises consciousness of the problem. But Dr. McIntosh sagely asks,

“What will we do with such knowledge? It is an open question of whether we will choose to use unearned privilege to weaken hidden systems of advantage and whether we will use any of our arbitrarily-awarded power to reconstruct power systems on a broader base.”

THE ROLE OF HISTORICALLY BLACK COLLEGES & UNIVERSITIES

Dr. Lily McNair, Associate Provost of Research and Professor of Psychology at Spelman College in Atlanta, GA, spoke at WIA2009 of the specific successes at Spelman and the important role of historically black colleges and universities (HBCUs) generally. Founded in 1924, Spelman is an all-female HBCU of 2150 students, 30% of whom major in STEM fields. In 2008, the National Science Foundation ranked Spelman as the #2 undergraduate institution origin of black PhDs in STEM fields (the NSF report was published in the January 2009 issue of Spectrum: http://csma.aas.org/spectrum_files/spectrum_Jan09.pdf)

So how did Spelman achieve this success? The first step is to create a culture inclusive of women and minorities. Spelman generated this supportive environment through many activities: tutorial programs, informal social events within majors, small class sizes (11 students:1 professor), and mentorship from alumnae.

The second step is to promote an environment of academic excellence. Spelman emphasizes undergraduate research through training programs and collaborations with nearby scientific institutions (e.g., Georgia Tech, Emory, Georgia State). Spelman hosts a college-wide Research Day to highlight students' work, and they support student travel to research conferences. Spelman is also involved in several interdisciplinary programs (in fields like informatics and robotics) that encourage student participation and teamwork.

WHAT ABOUT MAJORITY INSTITUTIONS?

Majority institutions can emulate Spelman's strategies to achieve similar results. For example, Earnestine Baker presented information on the Meyerhoff Scholars Program at the University of Maryland, Baltimore County. Mrs. Baker is the head of this program, which began in 1989 to increase the diversity of STEM PhD recipients. The Meyerhoff Scholars Program supports high-performing students all four years who plan to pursue science careers and who are committed to increasing the representation of minorities in STEM disciplines.

Like Spelman, the Meyerhoff Scholars Program succeeds by creating a culture of inclusiveness and by promoting an environment of academic excellence. Since its start twenty years ago, the program has graduated over six hundred students, and these alumni have earned 53 PhDs, 21 MD/ PhDs, 74 MDs, 115 MSs, and 85 graduate degrees in engineering. The program is shown to have a dramatically positive impact on students' success: Meyerhoff Scholars are 5.3 times more likely to have earned or be working toward a STEM PhD than students who were invited to join the program but declined and attended another university.

BRIDGE PROGRAMS

Majority institutions can also partner with minority-serving institutions to create mutually beneficial programs that support the success of their students. One such program, the Fisk-Vanderbilt Masters-to-PhD Bridge Program, was described at WIA2009 by Professor Keivan Stassun of Vanderbilt. This program has students complete their Master's degree in physics or biology at Fisk University (an HBCU in Nashville, TN) and transition to earn their PhD in astronomy, physics, biology, and material sciences at nearby Vanderbilt University. This program enables students to develop the strong

academic foundation, research skills, and mentoring relationships that help them succeed in their graduate careers and beyond.

Bridge programs are a novel approach for enhancing diversity in STEM fields. Research shows that minorities are 50% more likely than non-minorities to earn an MS degree en route to their PhD [4], and minorities are also more likely to earn their bachelors, masters, and PhD from three different institutions. Thus, institutional collaboration, like the one Fisk and Vanderbilt have established, is a pragmatic solution to address minorities' "leaky pipeline" in STEM disciplines.

LESSONS & OUTCOMES

The last day of WIA2009, the organizers and several astronomy graduate students and postdocs met with Tina Tchen, Director of the White House Office of Public Engagement and the Executive Director of the WH Council on Women and Girls. The speakers at the event highlighted six major areas of concern for early-career scientists based on discussions from WIA2009: the long career path to becoming a professional astronomer, health care (including domestic partner benefits and dependent care coverage), family leave policies, unconscious biases in the workplace, the importance of education and public outreach, and the critical role of mentorship. Tchen listened attentively to these points, and she remarked afterward that she had been unaware how top policy issues like health care had such a direct influence on the retention of women and minorities in the sciences.

Several lessons can be drawn from WIA2009. General awareness of a problem is an important first step, and data/studies regarding the problem are vital to substantiate claims. Conscious and deliberate efforts are imperative to promote fair practices and policies. Individuals can make a substantial impact. Programs that create a culture of inclusiveness and encourage academic excellence are highly effective at retaining women and minorities. Together, these lessons provide a guide for how astronomy can diversify its workforce.

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XII. LAST WORDS



AMY A. SIMON-MILLER

NASA/Goddard Space Flight Center

Conference Closing Remarks

Amy A. Simon-Miller, NASA/GSFC, Women in Astronomy and Space Science III, 2009. Presented at the Inn and Conference Center, University of Maryland, University College, October 23, 2009

What a very long way we have come since the first Women in Astronomy meeting in 1992 in Baltimore! At that inaugural meeting it was pivotal to define the issues, which at the time included blatant discrimination, to put a framework on why this was a critical problem, and to promote inclusiveness and fairness for all in the field. Essentially, it was a wake-up call to the community that there was a problem, and it should be addressed. Yet, many were still reluctant to endorse the Baltimore Charter, perhaps because it meant admitting to uncomfortable truths and inequities.

In 2002, the AAS Committee on the Status of Women realized that it had been a milestone 10 years since the first meeting. Thus, at the second Women in Astronomy meeting in 2003 in Pasadena, it was time to see if the statistics had changed in 10 years, to determine what progress had been made and to tackle the more subtle aspects of discrimination. It was also time to make the bold statement that the subject was not a “women’s problem” to be dealt with only by those experiencing the discrimination. It was everyone’s problem, and many of the same issues affected male astronomers, as well as underrepresented minorities. Of course, by this time, many more studies had been done on inequities in the workplace, and many institutions had conducted visits by independent committees, with often eye-opening results. Therefore, the focus of the second meeting was to show examples of the places where inequity still existed while also offering some thoughts on solutions. The Pasadena Recommendations, which were later endorsed by the AAS Council and many department chairs, offered suggestions on ways to improve the overall climate in astronomy.

These two documents have helped to shape how many institutions view their workforce. What has become apparent is “diversity is aligned with excellence,” as stated so eloquently by several meeting attendees. By eliminating two-thirds of the talent pool, one won’t have the best possible workforce or the diversity of ideas any institution needs to thrive in today’s competitive environment. Though, while all departments and groups hope to recruit, hire, and retain the best and the brightest, it is not always obvious how to do that. For example, too often we rely on candidates to apply for a position, instead of real recruiting, and then we allow unconscious bias to drive the results. For those who are successful, the increased workforce diversity causes new problems to emerge for both the manager and the employees who then expect these new hires, or students, to “fit the mold.”

This very thought was the impetus for the 2009 Women in Astronomy and Space Science III meeting; how can we compile a list of practical solutions and best practices that would be a helpful starting point for institutions and individuals? For institutions and managers, these included a discussion of how to broaden the recruiting pool through bridge programs and

targeted scholarships, how to mentor young hires, and how to recognize the unconscious biases we all hold, in order to make sure they are not drivers in hiring, promotions, awards and assignments. There were also discussions for all stages of your career, including finding alternate career paths, negotiating skills, learning when to say no to service, and managing family responsibilities and career beaks.

Thus, many important topics were presented at this meeting: from a snapshot of the current statistics of the field, to real-world solutions for managing a diverse workforce, to finding solutions for navigating your own career. On behalf of the WIA2009 Organizing Committee, I hope these Proceedings will be of use to many, and that invaluable contacts were made at the Networking functions at the meeting. This conference was dedicated to the memory of Dr. Beth Brown, and she would have been proud to see the wonderful attendance, particularly by students and early career participants. For those of you who love statistics, final registration was 281 participants, compared with 184 for the first meeting and 155 for the second meeting. A special thank you to our sponsors, speakers and attendees for making this meeting such a success!

We look forward to seeing you at the next meeting; though perhaps the field will soon have reached such equity that a fourth meeting is not needed!



Attendees of the 1992 Women in Astronomy meeting, Baltimore, MD.



Attendees of the 2003 Women in Astronomy meeting, Pasadena, CA.



Attendees of the 2009 Women in Astronomy and Space Science meeting, College Park, MD.

Women in Astronomy and Space Science III, 2009 Conference, October 21-23 • ATTENDEES

Aarnio	Alicia	Vanderbilt University
Akeson	Rachel	NExSci/Caltech
Alatalo	Katherine	UC–Berkeley
Allen	Marc	NASA Headquarters
Anderson	Carrie	NASA/GSFC
Andrews	Jennifer	Louisiana State University
Bagenal	Fran	University of Colorado
Baker	Earnestine	Univ. of Maryland Baltimore County/Myerhoff Scholars Program
Ballinger	Theresa	GSFC/NASA
Barger	Kat	WHAM–University of Wisconsin
Bastian	Tim	NRAO
Bastien	Fabienne	Fisk/Vanderbilt University
Basu-Zych	Antara	NPP-Goddard Space Flight Center
Bates	Lakesha	NASA-GSFC
Bertschinger	Ed	Massachusetts Institute of Technology
Bianchi	Luciana	Johns Hopkins University
Bjorkman	Karen	University of Toledo
Blaha	Cindy	Carleton College
Bodnarik	Julia	NASA/GSFC
Bogdanovic	Tamara	University of Maryland–Astronomy
Bonning	Erin	Yale University
Bornak	Jillian	New Mexico State University
Boyer	Martha	Space Telescope Science Institute
Bregman	Joel	University of Michigan
Brickhouse	Nancy	Smithsonian Astrophysical Observatory
Bruff	Sheryl	Space Telescope Science Institute
Brutlag	Kate	University of Arizona/Steward Observatory
Bullock	Blake	Northrop Grumman
Buratti	Bonnie	JPL Caltech
Burgasser	Adam	UC San Diego
Burke	Bob	Northrop Grumman
Cahoy	Kerri	NASA Ames Research Center
Canizares	Claude	Massachusetts Institute of Technology
Cardamone	Carolin	Yale University
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PROGRAM/AGENDA

TUESDAY, OCTOBER 20

- 1:30 p.m. Afternoon Career Development Workshop: “COACHing in the Art of Strategic Negotiation,” *Ernestine Taylor & Jane Tucker/COACH*
Room 0105
- 5:30 Registration Reception
Founders

WEDNESDAY, OCTOBER 21

- 8:00 a.m. Opening Comments, *Anne Kinney/NASA GSFC*, Aud.
- 8:15 Keynote Welcome, *Ed Weiler/NASA Associate Administrator*,
Science Mission Directorate
- 8:30 Longitudinal Study Status, *Rachel Ivie/AIP*
- 9:00 NRC Study on STEM Faculty *Claude Canizares/MIT*
- 9:30 IAU Study on Statistics, *Catherine Cesarsky/IAU*
- 10:00 30 MINUTE BREAK
- 10:30 Addressing Unconscious Bias, *Abigail Stewart/UMich*, Aud.
- 11:15-12:00 Building the Next Generation of Astronomers, *Joyce Winterton/NASA HQ*
- 12:00 p.m. LUNCH
- 1:15 Introduction, *Nick White, NASA/HQ Sciences & Exploration Director*, Aud.
- 1:30 Panel Discussion: How the Professional Community can Impact Percentages and Retention, *Chair: Meg Urry/NSF, Panelists: Jim Ulvestad/ NRAO, Debra Elmegreen/ Vassar College, Matt Mountain/Space Telescope Science Institute, Lee Anne Willson/Iowa State University*
- 2:30 HBCU Perspectives and Research Programs, *Lily McNair/Spelman College*
- 3:30 15 MINUTE BREAK
- 3:45 Poster Session, Grand Concourse
- 6:00 Networking Event/Dinner
Film celebrating Beth Brown’s life will be shown at the beginning of dinner.
Founders and Ft. McHenry

THURSDAY, OCTOBER 22

- 8:00-8:45 a.m. Women in Science and Engineering: Exploring what A-MAZE's Us Kathie Olsen/NSF, Senior Advisor, Aud.
- 8:45-9:15 Preserving our Intellectual Capital: An Institutional Perspective, *Mark Sykes/PSI Director*
- 9:15-10:15 Panel Discussion: To Boldly Go: Paths to Non-Academic Careers, *Chair: Colleen Hartman/GWU, Panelists: Orlando Figueroa/NASA GSFC, Ron Polidan/Northrop Grumman Aerospace Systems, Kathleen Flint/National Postdoctoral Association, Loretta Hidalgo Whitesides/Executive Director, Yuri's Night, Renetta Tull/UMBC*
- 10:15-10:45 30 MINUTE BREAK
- 10:45-11:15 Dedication to Dr. Beth Brown, *James Lindesay, Howard U.*, Aud.
- 11:15-12:00 p.m. Generational Issues in the Scientific Workplace, *Paula Rayman/U Mass, Lowell*
- 12:15-1:45 LUNCH
- 1:45 Re-Entry: Career Breaks in Physics, *Elizabeth Freeland/Washington U.*, Aud.
- 2:30 Panel Discussion: Parenthood: The Elephant in the Laboratory, *Chair: Anne Douglass/NASA GSFC, Panelists: Heidi Newberg/RPI, Mark Olsen/NASA GSFC, UMBC, Emily Monosson, Author*
- 3:30-4:10 Meyerhoff Scholars Program at UMBC, *Earnestine Baker/UMBC*
- 4:15-4:45 Hubble's Diverse Universe, Film by *Jarita Holbrook, U. of Arizona*
- 4:45 - 6:30 Poster Session, Grand Concourse
- 6:30 DINNER
- 7:00 Remarks, *Christopher Scolese/NASA HQ, Founders and Ft. McHenry*

FRIDAY, OCTOBER 23

- 8:00 a.m. Introduction, *Rob Strain/GSFC Director*, Aud.
- 8:15 Keynote Address, *Congresswoman Donna F. Edwards*
- 8:30 Unearned Advantage and Disadvantage as Work Impediments, *Peggy McIntosh/Wellesley College*

- 9:30 Work Environment Parallel Sessions:
1. Research is not Enough: Negotiating all the Rest, *Fran Bagenal/U. of Col., Catherine Mavriplis/U. of Okla., Jim Green/NASA HQ*, Founders
2. Panel Discussion: What it takes to become a PI, Project Scientist or Instrument Scientist, *Chair: John Mather/NASA GSFC Panelists: NASA/GSFC, Julie Mc Enery, Jean Swank, Sally Heap, Joanne (Joe) Hill*, Aud.
3. How to be a Mentor, *Mark Goldman/NASA GSFC*, Ft. McHenry
4. Leveraging Partnerships with Minority Serving Institutions, *Keivan Stassun/Vanderbilt U. and Kelly Holley-Bockelmann/Vanderbilt U. Chesapeake*
- 10:15 15 MINUTE BREAK
- 10:30 Summaries of Parallel Session Breakouts, Group Leads, Aud.
- 11:30 Closing Remarks, *Amy Simon-Miller/NASA GSFC*

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