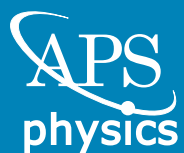




GENDER EQUITY

STRENGTHENING THE PHYSICS ENTERPRISE
IN UNIVERSITIES AND NATIONAL LABORATORIES
MAY 6-8, 2007





“If you make all your women students and faculty feel more valued by your speech and actions—including speaking up for family friendly practices—and if you publicly chastise those that make demeaning or snide comments, you will find the rewards are great.”

Judy Franz, APS

GENDER EQUITY

REPORT OUTLINE

EXECUTIVE SUMMARY	4
SECTION 1: ACTION ITEMS	5
Physics Departments and National Laboratories	
1.1 Recruitment	5
1.2 Climate	6
1.3 Retention	6
Funding Agencies	
1.4 Building a Diverse Community	7
1.5 Improving the Grant Process	7
1.6 Outreach/Pipeline-Building	8
SECTION 2: REPORT	9
The Changing Face of Physics: Considering the Issues	11
Subtle but Crippling: Bias in Physics Programs and Research Institutes	13
All the Best Minds: Recruiting and Retaining the Next Generation of Women, Minorities, and Men.....	16
Recruiting Students, Faculty, and Staff.....	16
Promoting Change	18
Plugging the Leaks: Keeping Women in the Pipeline	20
SECTION 3: CONCLUSION.....	21
SECTION 4: REFERENCES	22
SECTION 5: WORKSHOP SCHEDULE	24
SECTION 6: WORKSHOP PARTICIPANTS.....	26
SECTION 7: ACKNOWLEDGMENTS	31

GENDER EQUITY

EXECUTIVE SUMMARY

Maintaining a strong workforce in the physical sciences is of critical importance to the national economy, health care, defense, and domestic security. Increasing the participation of women in these sciences can strengthen that workforce by widening the available pool of talent[1]. Despite the quite considerable increase in the number of female physics faculty over the past three decades, women still represent only 13% of faculty of all ranks from the 760 degree-granting physics departments in the United States[2] and only 9.5% across all ranks at the major research universities[3]. By contrast, all other disciplines measured except mechanical engineering are doing better than physics. If the nation is to enjoy the benefits of further significant increases in the participation of women in the physical sciences, the representation of women on the faculties of research universities must be increased. These women faculty play a critical role in the encouragement of women students.

Following the increase in accessibility to professional degrees that women have encountered since 1964, and the gradual reduction in barriers to obtaining science, technology and math employment for women, we have seen the percentage of PhD's awarded to women increase from 4% in 1974 to 18% in 2006[18]. At the same time, the percentage of assistant professors who are women in the top 50 physics departments has increased to 17.5%, which is currently on par with the representation of women in the relevant PhD pool.

Nevertheless, the physics workforce in academia and national laboratories remains one of the last areas in science where women are significantly under-represented relative to their proportion in the population. The reasons for this imbalance are many, as are the solutions, but the primary motivation for changing this situation should be to provide greater encouragement to women to enter and remain in physics. To ensure that both women and men are given equal opportunities in the field, physics departments and national laboratories, with the involvement of funding agencies, need to increase their commitment to clearing away existing barriers, encouraging women's participation in programs and their access to awards and grants, and to making academic and research environments respectful of all participants.

To help accelerate this trend of increasing participation, the Committee on the Status of Women in Physics (CSWP) of the American Physical Society (APS) followed the example of the chemistry community[4] by organizing a workshop to address this disparity entitled "Gender Equity: Strengthening the Physics Enterprise in Universities and National Laboratories." The event, co-funded by the National Science Foundation (NSF) and the Department of Energy (DOE), was held at APS headquarters in College Park, MD, on May 6-8, 2007. The major aim of the workshop was to facilitate a doubling of the number of women in physics in both academia and national laboratories over the next 15 years. The active participation of physics department chairs, national laboratory managers, and federal agencies encouraged exciting new ideas to emerge, aimed both at making the field of physics more attractive to women and men and at finding effective ways to retain women in physics. The workshop examined the underlying causes for the scarcity of women in physics, and participants formulated specific suggested action items that will improve the recruitment, retention, and promotion of female students, postdoctoral fellows, faculty, and scientists in academia and national laboratories.

The action items that emerged from the meeting are divided into: A. suggestions directed primarily at physics departments and national laboratories and, B. those directed to the funding agencies. If adopted, they are expected to lead to significant increases in the number of women physicists and improvements in the atmosphere and climate for faculty/scientists and students at all levels, regardless of gender. During the next six months, chairs and managers of all physics organizations are urged to commit to consider the recommendations carefully and to begin implementation of some of these items, especially those that will increase the number of women and help retain those women in their departments/laboratories. The interactive APS website is set up to facilitate the documentation of actions taken as well as the sharing of ideas with other chairs and managers. (The site is accessible from the Women in Physics page of the APS website, see Programs). A follow-up workshop is tentatively planned for 2009.

GENDER EQUITY

1

ACTION ITEMS

The most important product of the Gender Equity workshop is a list of action items that emerged from the workshop sessions (see Appendix 1) and were then reviewed by the Co-Chairs and the Organizing Committee. These items are broken down into those that target physics departments and national laboratories and those suggested for funding agencies.

PHYSICS DEPARTMENTS AND NATIONAL LABORATORIES

1.1 Recruitment

Increasing the number of women in physics involves both increased hiring of women at all academic levels as well as the active seeking of new women majors at both the undergraduate and graduate levels. Recommendations include:

- ▶ Actively recruit women. Keep apprised of women in the pipeline and let them know you would like them to apply for positions at your institution. Have faculty/scientists help keep a current list of up-and-coming women.
- ▶ Advertise broadly for positions to attract more women candidates with different backgrounds. It has been observed that women are not likely to apply for positions that have tightly constrained qualifications unless they see a near exact fit.
- ▶ Invite more women to interview. It is documented that women often under-sell themselves when compared to men. Digging deeper into the candidate pool might identify an excellent fit that is not immediately apparent.
- ▶ Mentor postdoctoral associates (and graduate students where appropriate) into faculty or scientist positions. Advice on how to succeed in the academic or the national laboratory arena will help them better prepare themselves for hiring and for coping with the difficulties inherent to the field.

Increasing the number of applicants to academic and scientist positions must be accompanied by unbiased review of the applicants. Search committees and those making hiring decisions must be able to recognize the signs of

unintended bias and to be able to compensate for this when evaluating candidates. Suggestions for improving hiring practices to increase the number of women hired include:

- ▶ Provide training for search committee members in the recognition of unintended bias. It is particularly important that those reviewing applicants be aware of the role of unintended bias in the writing of letters of recommendation. Those interviewing candidates should be advised of the types of questions allowable in an interview and guidelines for equitable treatment. Questions should focus on job-related issues, and avoid questions of a personal nature such as marital or family status.
- ▶ Have candidates meet with a diverse group of individuals including graduate students, postdocs, and women inside and outside the department/national laboratory unit to get a sense of the environment at the institution.
- ▶ Women physicists are much more likely than men to marry other scientists[6]. Many universities have creative solutions for hiring a pair of individuals, such as upper-administration assistance in offering an additional position, or partial payment of the spouse's salary to another department or institution during some fraction of the pre-tenure period. Investigate these arrangements well in advance of hiring so that your job opening will be more attractive to woman candidates.

Achieving an increase in the number of women in academic and scientist positions also requires addressing pipeline issues. Increasing the number of women physics majors at all stages of study is also necessary. Recommendations for doing so include:

- ▶ Actively recruit female physics majors, especially through interaction with high school physics students. Nearly 50% of high school physics students are female, so active recruitment from high school physics classes is likely to increase the percentage of women in the undergraduate major. Students should be informed of the diverse career paths open to them with a bachelor's degree in physics, since only 1 in 7 bachelor degrees in physics will go on to receive a PhD in physics[5]. Participation of female undergraduate physics majors in high

ACTION ITEMS

school recruitment programs will serve both to show potential female majors a career path while at the same time engaging the female undergraduates, increasing the likelihood of having them continue further in physics studies.

- ▶ Actively recruit female physics graduate students. MIT and other physics departments rely on female physics graduates to visit feeder undergraduate physics departments as a way of increasing the number of women in their graduate programs.
- ▶ Make it easier to enter a physics program after the first year to allow for late starters or those with lower initial preparation in mathematics. Create flexible tracks for physics majors to allow interdisciplinary studies or to pursue an education degree.

1.2 Climate

Recognizing that departmental climate is a strong factor both in attracting women to physics as well as in retaining them, the following items are recommended for improving the satisfaction of employees and students:

- ▶ Chairs/Managers should schedule regular meetings (at least once a year) with female students in their organizational unit to get their opinion of the environment for women in that unit. This can also be useful with postdoctoral associates or early career faculty/scientists.
- ▶ A mentoring committee of women faculty/scientists and students should be formed.
- ▶ Have a zero-tolerance policy for offensive comments. Chairs and managers should set the example by challenging offenders, perhaps even publicly, and making it known that comments of this nature are inappropriate and will not be tolerated. Make sure harassment policies are clear, equitable, and enforced uniformly.
- ▶ Ensure that all policies (e.g., hiring, tenure, promotion, harassment, discrimination, space allocation, teaching assignments, etc.) are transparent and easily available to all. It is suggested that these be posted electronically for easy and anonymous access.
- ▶ Develop policies that support a work/life balance for all. Examples include allowing personal leave for dependent care, or setting meeting times that do not interfere with parental responsibilities.

“Spreading best practices through workshops makes the environment better for everyone, not just women.”

Patricia Rankin,
University of Colorado

- ▶ Ensure meetings are run fairly for all by providing training for faculty/scientists on meeting facilitation.
- ▶ Publicly recognize awards and achievements for all in an equitable manner.

1.3 Retention

- ▶ Provide new faculty/scientists with more than one mentor, and encourage faculty/scientists to seek out additional mentors and support networks. Provide mentors with training that includes issues relevant to gender and cultural issues.
- ▶ As a chair/manager, follow the careers of new faculty/scientists, and check in frequently on the status of their activities. Corporate managers often use a technique called “coaching by walking around” to gain insight into employee activities and provide support. Chairs/managers can provide an open atmosphere of support and encouragement through informal visits and an open-door policy.
- ▶ Form an early-career faculty/scientist committee to encourage networking and to enable anonymous feedback of the department’s/unit’s environment to the chair/managers.
- ▶ “Stopping the tenure clock” for family leave should be available at all institutions for both women and men. Although at some institutions this has been viewed as a stigma, policies should be developed and chairs/managers should make public comments to encourage all faculty/scientists to take advantage of this option. Such policies should make the extension automatic while allowing the scientist the option to be evaluated for tenure on the original schedule.
- ▶ Nominate women for both small and large awards, prizes, and honors to recognize their accomplishments. This will help build their reputations and enhance their chances for winning larger awards.

FUNDING AGENCIES

1.4 Building a Diverse Community

Funding agencies have a role to play in ensuring that women and under-represented minorities remain in physics by seeing that the granting process is balanced, fair, and does not discount applications from the broader community. To enhance this role, the following items are suggested:

- ▶ All funding agencies need to collect data on gender

ACTION ITEMS

and minority status in funding support. These data should be aggregated and made publicly available.

- ▶ The funding agencies should set clear guidelines on building diversity and ensure that these values are incorporated in the award process. Awareness of diversity issues should be embedded at all decision-making levels in the funding agencies and at the national labs that they fund. For example, the National Science Foundation (NSF) “broader impacts” criterion can be used to encourage diversity among grant awardees and those supported by these grants, but applicants and reviewers may not understand how this is to be interpreted. Such policies should be clearly stated and explained.
- ▶ Funding agencies should continue to support workshops and other activities to promote diversity and to monitor progress on gender equity. Programs that enable early-career women to establish research programs leading to tenure should be created. In addition, funding for implementation of programs developed under NSF ADVANCE grants, which have been extremely beneficial to women, needs to be increased to allow more national programs across the US.
- ▶ Funding agencies and institutions should brainstorm additional ways to increase the diversity of the grantees.

1.5 Improving the Grant Process

Currently, the population of women in physics is skewed toward early career physicists. Programs to target early career scientists may help enhance the number of women receiving grants. In addition, the complexity of the granting process often discourages early career physicists from pursuing academic careers. Their success in obtaining early funding is a factor both in allowing them to obtain faculty positions as well as in their ability to achieve tenure. To improve the process of securing funding among women and under-represented populations, the following suggestions are made:

- ▶ To improve the prospects for early career scientists to obtain grants, support should be made available for programs that educate postdocs and graduate students about the grant writing process.
- ▶ Early career faculty/scientists should have the means to meet with program officers. Agencies are encouraged to set up individual and group meetings with program officers at conferences.
- ▶ It is very helpful for junior people if they can get the opportunity to learn what is important to reviewers. Funding agencies are encouraged to include early career researchers on their review panels.
- ▶ Sustained funding for scientists is as important as

starter grants. It is suggested that the proposal process be streamlined as much as possible to enhance overall productivity.

- ▶ The agencies should better advertise small grants for exploratory research, if they have them, or consider creating similar opportunities if they do not.

To ensure fair consideration in the granting process, the following items are suggested:

- ▶ Evaluation criteria for grant applications should be set in advance and should be clear.
- ▶ Important decision-making panels should have a critical mass of women, although it is important not to overburden the women who are frequently tasked to serve on them. We encourage funding agencies to keep track of who is asked to serve on committees and make an effort to include some of the lesser-known women.
- ▶ Reviewers should be sensitive to the elements of hidden bias that can enter the review process. A short discussion on diversity at the beginning of all agency review panels and other meetings where decisions on resources are made is encouraged. Specific examples, both good and bad, should be given on items that could arise, such as gaps in a résumé due to family issues or the accumulation of subtle biases.

Recognizing that concerns for the ability to balance family needs with the demands of an academic career often discourage women from pursuing faculty positions, steps to improve work/life considerations for grant recipients are suggested:

- ▶ Research grants with a longer structure (4-5 years) and more umbrella grants would significantly reduce the overhead of maintaining a successful research program while making research more attractive to early career scientists. All funding agencies are encouraged to form a task force to review the optimum balance between long/short grant periods and individual/group awards.
- ▶ To help enable transitions for those re-entering the workforce after having children, the length of time for people to work on their grant should be extended by the length of time taken off for child-rearing. The ability to do this with a no-cost extension should be widely publicized.
- ▶ Funding agencies should be supportive of university maternity/family leave options for graduate students. Small supplements to grants should be allowed if an additional person is needed on the project to maintain momentum. No-cost extensions and/or re-allocation of funds as well as allowances for slower progress in these situations should also be an option for the PI.

ACTION ITEMS

- ▶ Funding agencies should provide ways to ensure that childcare needs do not prevent attendance at professional meetings.
- ▶ Agencies should consider a task force to brainstorm ways to help people to transition through life changes (children, elder care, etc.) and continue to be part of the scientific workforce. Examples of programs that would retain people in the field include:
- ▶ Grants that allow faculty to focus on research but decrease teaching/service activities following family care/life changes.
- ▶ Grants funding additional post-docs to help keep a lab active during a family leave.
- ▶ Re-tooling grants for people returning after a short absence.

1.6 Outreach/Pipeline-Building

- ▶ Support for outreach activities, particularly those which would encourage early career female and minority students to consider physics careers, should be made available not only to PIs but also to departments and institutions.
- ▶ DOE has encouraged its labs to reach out to the community, e.g., via its summer programs for teachers. These activities should receive continued support.
- ▶ All funding agencies should increase post-doctoral awards with mentoring components, such as DOE national laboratory fellowships (Lawrence, Oppenheimer, Wilson, etc.)
- ▶ Opportunities for more postdoctoral exchanges between universities and national labs are valuable and should be a priority for funding.

“Constant collection and monitoring of data to chart equity progress, coupled with attention to family friendly policies, subtle biases in promotion and tenure processes, and support from top leadership are needed for women to advance in academic science.”

Sue Rosser, Georgia Tech

GENDER EQUITY

2

REPORT

The glaring gender gap in university physics departments and physics-related national laboratory organizational units poses serious problems for the field. In an economy that depends heavily upon science and technology, the talent pool of physicists is at best only holding steady, not increasing, despite the number of physics students in high schools and the fact that nearly 50% of high school physics students are girls. By the time these girls declare their majors as undergraduates, many of them have already “leaked” from the pipeline, and many more continue to do so throughout their academic careers. At the full professor and equivalent research rank, their numbers are very low—between 6 and 7% in the most recently available data (see Table 1), a smaller fraction than almost every other discipline measured and only about half of the percentage in astronomy (see Table 2). Workplace diversity optimizes the creativity and research productivity of both men and women; a lack of gender equity means fewer of the best minds are available for physics education and research. Offering equal opportunities for success in their chosen fields to both women and men not only benefits the field; it is the right thing to do.

The under-representation of women in physics has been the concern of the Committee of the Status of Women in Physics (CSWP) of the American Physical Society (APS) since its formation in 1972. Despite the fact that the problem has been debated and discussed at international conferences [8] as well as reported [9] and published in various journals [10-17] and newspapers, progress remains slow. Judy Franz of APS points out that, over her 40-year career, the percentage of women in physics has increased on average by about 0.4% per year. As a result, early career women are seeing no obvious improvement in the status quo during their shorter professional careers. At this rate, women will account for only 1 in 4 new doctorates by the year 2028 (see Figure 1).

The recent successful workshop organized by the chemistry community, “Building Strong Academic Chemistry Departments through Gender Equity,” [4] encouraged CSWP

to also hold a similar workshop for the physics community entitled “Gender Equity: Strengthening the Physics Enterprise in Physics Departments and National Laboratories.” The ultimate goal of the workshop was to begin facilitating a doubling of the number of women in physics over the next 15 years. It brought together academic and national laboratory leaders with social scientists and senior management from physics funding agencies to look at data on the representation of women in physics, learn possible reasons for the trends, and work together to formulate ideas for approaching the under-representation problem. While the physics and chemistry workshops were similar, the CSWP workshop also involved participants from DOE national laboratories and included a session on education and pipeline issues. Planned by a steering committee of academic and national laboratory researchers from the physics community, the

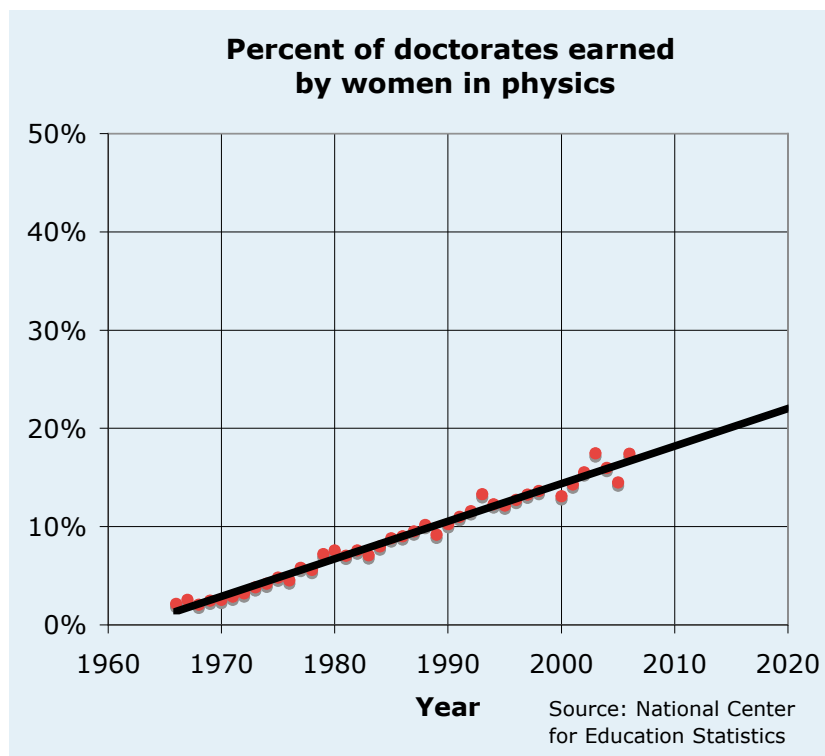


Figure 1. Fraction of physics PhD's earned by women showing a 0.4% annual increase [18]

GENDER EQUITY

ACADEMIC RANK	1994	1998	2002	2006
Full Professor	3	3	5	6
Associate Professor	8	10	11	14
Assistant Professor	12	17	16	17
Instructor/Adjunct	N/A	N/A	16	19
Other Rank	8	13	15	12

TYPE BY DEPARTMENT

Doctoral	5	6	7	10
Master's	7	9	13	16
Bachelor's	7	11	14	19
OVERALL	6	8	10	13

Table 1. Percent of faculty positions in physics held by women[7]

DISCIPLINE	Assistant Professor	Associate Professor	Full Professor	All Ranks
Physics	17.5	12.6	6.8	9.5
Astronomy	25.3	21.6	12.3	15.8
Chemistry	21.7	21.3	9.7	13.7
Math	28.0	15.5	7.2	12.1
Computer Science	19.5	11.3	11.5	13.5
Chemical Engineering	23.7	17.8	8.3	12.9
Civil Engineering	25.3	14.3	7.1	12.7
Electrical Engineering	14.5	14.1	6.2	9.7
Mechanical Engineering	18.2	12.0	4.9	9.0

Table 2. Percentage of female faculty within each rank at top 50 research universities (FY2007)[3]



APS president Arthur Bienenstock (Stanford University) and CSWP chair Nora Berrah (Western Michigan University), co-chairs of the workshop

workshop consisted of presentations, panel discussions, and breakout sessions. In addition, an interactive theater skit by the University of Michigan's Center for Research on Learning and Teaching (CRLT) illustrated, in a visceral way, the kinds of unconscious bias often faced by women in physics. Presentations by social scientists provided data analyses to support what is often seen as merely anecdotal evidence.

The workshop, co-chaired by Professors Nora Berrah (CSWP Chair, Western Michigan University) and Arthur Bienenstock, (then APS president-elect, Stanford University), brought together the chairs from 50 research-oriented physics departments that grant the most physics doctorates and/or receive the most federal research money. This group of prestigious schools was chosen for their ability to model positive behaviors and to influence other schools across the country. Fourteen managers from the thirteen national laboratories for which the DOE Office of Science or the National Nuclear Security Administration (NNSA) has a stewardship role also participated. This small sample of leading institutions was selected for the ability to generate action items that can be applied by all organizations nationally and internationally through mutual cooperation. The workshop was conducted with support from the National Science Foundation's (NSF) Physics, Astronomical Sciences, and Materials Research divisions, and the DOE Office of Science (including Basic Energy Sciences, Nuclear Physics, High Energy Physics, Fusion Energy Sciences, and Advanced Scientific Computing Research). In addition, the organizing committee was advised by members from both federal agencies.

The workshop pursued three main objectives: 1. raise awareness of the current status of women in physics and gender-related issues; 2. generate recommendations for best practices to attract, hire, retain, and increase the numbers of women faculty and scientists in physics; and 3. generate best practices to recruit, retain, mentor, and educate students who represent the next generation. The action items listed above are the result of this workshop, and attendees were asked to commit to actions appropriate to their institution. APS encouraged their implementation by establishing an interactive website to record attendees' long-term progress in carrying out their selected action items.

To evaluate the effects and success of the workshop, pre- and post-workshop surveys similar to those used for the chemistry gender equity workshop were administered by the Committee on the Advancement of Women Chemists (COACH), which assessed attitude changes in the participants. In addition, an evaluation questionnaire was used to record feedback on the workshop format and content.

Three themes emerged from the workshop: the necessity of changing gender inequity in physics; the specific factors that need to be changed (such as an unfriendly or even hostile working environment, low awareness of unconscious biases, and lack of policies which support the realities of caregiving experienced by both women and men); and ways to recruit, retain, and support women in physics.

The Changing Face of Physics: Considering the Issues

The importance of achieving gender equity in physics is a matter of national importance. The economic leadership of America is directly tied to science and technology (S&T); 50% of the productivity increase that has occurred in the last half-century can be attributed to advances in science and technology, and the number of Americans employed in S&T has grown steadily, from 11% in 1962 to 15% in 1995[17]. Historically, these workers have largely come from the white male population. However, demographic projections show a steady decline in the fractional representation of this group in the population over the next half-century. In order to meet the demands of the continued growth of the S&T sector and sustain national productivity growth, it is crucial to make full

“Minority students earning PhDs in the physical sciences are ~50% more likely to earn a master’s degree en route; students often must navigate the transition from the master’s to the PhD with little or no structured mentorship.”

Kevin Stassun, Vanderbilt University

REPORT



Tony Chan, Assistant Director, NSF Directorate for Mathematical and Physical Sciences



Patricia Dehmer, Associate Director of Science for Basic Energy Sciences and Acting Deputy for Programs, DOE Office of Science

use of the talents of women and under-represented minorities. Otherwise, a serious shortfall in technologically qualified workers will occur just as the US needs to increase this talent pool. As APS President Arthur Bienenstock pointed out in an early workshop session, as of 1995, 12% of people with undergraduate degrees in science and engineering working in the U.S. were foreign-born. Rising demand for scientists and engineers would require an increase in the immigration rate at a time when growing economies in China, India, and other developing areas are providing better opportunities for the pool of technologically educated immigrants.

But just how significant are the numbers of women in physics? The pre-workshop survey of physics department heads revealed that the chairs found a lack of women candidates as a moderate limitation on hiring faculty, so there is at least some perception that there are not enough women in physics to achieve equity[19]. However, statistics collected by the American

Institute of Physics (AIP)[7] show a steady growth in the percentage of degrees in physics earned by women: bachelor's degrees alone increased from 5% in 1966 to 22% in 2001. (Women earned 3% of PhD's in physics in 1973, 17.5% in 2003 and 15% in 2005.) In 2001, girls accounted for 46% of students in high school physics classes. This suggests that young women now entering colleges and universities provide a larger pool of potential physics and engineering majors than is currently being utilized.

The AIP study Women in Physics and Astronomy, 2005 [19] found that a much smaller fraction of women went on to earn an undergraduate degree (22%) in physics compared to the fraction of women who took high school physics (46%). Although this change is substantial, data also indicate that

women constitute a much smaller fraction of those who take the most advanced physics courses in high school, indicative of earlier systemic issues. The gender gap stabilizes at the graduate level, where retention rates for men and women are similar. The study also reports that the percentage of women pursuing academic careers in 2002 closely matches past degrees awarded.

Despite pipeline issues, the number of doctorates has been growing, too, if slowly. In 2003, 21% of those (US and foreign) enrolled in a physics graduate program were women, which hopefully will result in a subsequent increase in PhD graduates[9]. These women represent potential postdoctoral researchers and constitute the pool of the next generation of female faculty and scientists. Although these increases are promising, not enough is being done to retain women in the academic pipeline.

As pointed out by Patricia Dehmer, Associate Director of Science for Basic Energy Sciences and Acting Deputy for Programs in the DOE Office of Science, in the past, many academic programs leading to professional degrees had ceilings on the number of women who could enroll. Once those ceilings were abolished, fields such as law and medicine soon achieved gender parity. Many areas of science, such as biology and chemistry, have also made significant improvements toward gender parity. Yet physics, math, and engineering are still lagging. Surveys cited by Mary Ann Mason, Dean of the Graduate Division at University of California, Berkeley, displayed data on the disproportionate effect that motherhood has on a professional woman's career. These surveys show that while 48% of women entering PhD programs intended to have an academic career, by the time they received the PhD that number had fallen to 25%. The most common reasons given these surveys were 1. negative experience or feeling isolated in graduate school, 2. having children or a desire to have children, and 3. spousal considerations. Finally, Mason pointed out that the largest growth of faculty is at the adjunct level and this level is disproportionately populated by women.

“The best thing you can do for your students—female and male—is to become a feminist.”

**Howard Georgi,
Harvard University**



Arthur Bienenstock (Stanford University) highlighting the need of women in physics to benefit the US workforce.

If physics researchers were once almost exclusively male, that is certainly no longer the case. The presence of women in greater numbers brings a set of new concerns with it that the world of business has already been grappling with for quite some time. One might think that these concerns—family leave, caregiving, employment opportunities for spouses, balancing work and home life—affect only women. In reality, these issues are increasingly important to men, as well, and thus to the culture of physics itself, especially since women physicists are more likely to be married to fellow physicists, as Physics Department Chair Laurie McNeil of the University of North Carolina reminded workshop participants. If women with family responsibilities can be hampered in their careers by the present work structure, then men who have an equal interest in those areas can be too. Joseph Dehmer, Director of the NSF Physics Division, postulated that people generally become aware of equity issues either by having a personal experience watching what happens to a female friend or family member, or by enlightenment through cultural change, a much slower process. Building up to a tipping point can make a big change, and change for one gender can be good for both.

Because of the importance of physics to the nation, the government has an interest in encouraging gender diversity and enforcing anti-discrimination laws. For example, Sharon Wyatt, Attorney-Advisor for the DOE Office of Civil Rights and Diversity, reminded the audience that Title IX, which is federal law, requires that recipients of federal financial assistance ensure that all of their education programs and activities be free of discrimination on the basis of sex. This applies to hiring, admissions, housing, health insurance benefits, employment, financial aid, and course offerings. Title IX audits are now taking place at some universities. This may not be

the ideal vehicle for law enforcement, but as Wyatt further asserted, the goal is to stop discrimination, not to withhold funding.

Grantees' educational programs and activities must remain free of discrimination at every stage for the life of the grant. Wyatt added that, to achieve this, the DOE Office of Civil Rights and Diversity provides oversight and technical assistance to their offices. They conduct pre-award compliance reviews of proposed awards, desk audits, and post-award compliance reviews. At every stage in the process, DOE policy is to work collaboratively with the institution to eliminate or resolve any problems that may be uncovered. At the pre-award stage, there is the opportunity to resolve any problems with compliance.

As gender equity changes in other fields have shown, the nation's needs and the best interests of the physics community will best be met by making the field more attractive to undergraduates and master's degree students as well as to high school students.

Subtle but Crippling: Bias in Physics Programs and Research Institutes

As mentioned earlier, other areas of scientific research have made great strides in reaching gender equity. What is holding back physics? What encourages advances in other areas?

The National Academy of Science (NAS) provided some answers to this question in its report, *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*. The NAS committee explored the roles of nature and nurture in producing successful women in these fields, using meta-analysis of many studies. The study concluded that there is little difference in math SATs due to gender, and the differences between the performance of boys and girls in math is better explained by culture than by gender, as indicated by the shrinking of the gender gap over a single generation. It was noted that in Iceland, girls outperform boys in math while in developed Asian countries, girls outperform US students of both sexes in math. In terms of scientific productivity, the study found that if the

“Giving girls the background in physics greatly enhances their career opportunities across the board. All students should study physics in K-12 and should have multiple exposures.”

Millie Dresselhaus, MIT

REPORT



Alice Agogino (University of California at Berkeley), "Training search committees to recognize unintended biases and stereotypes is crucial"

data are controlled for the position of those being evaluated, the rate of publishing does not differ between the genders. Similarly, no impact on productivity could be attributed to marital or parental status or to responsibilities for elder care. At the same time there is extensive experimental evidence of subtle and unconscious bias. The overarching conclusion of the NAS report is that women in science and engineering are held back from achieving their full potential, not by a lack of drive or talent, but by unintentional biases and by institutional structures that hinder their advancement.

Social scientist Virginia Valian of Hunter College described how cultural perceptions and subtle bias still play a large part in how women are regarded and treated in the physics community. These biases are ingrained in the culture and often hard to detect. Citing her work in the Gender Equity Project at Hunter, she explains these biases as part of a "schema"—the shorthand people use for the efficient storage of cultural data. The ability to quickly retrieve these mental images contributes to the survival of our species and is continually reinforced, but schemas often contain a great deal of unintentional bias. Experiments in social cognition reliably show that men in male-dominated fields automatically receive preferential perceptions, negatively affecting women and minorities of both sexes.

Valian used the example of a typical schema for "physicist" consisting of a male more focused on his research than

social issues and showed how this contributes to unintentional bias. In general, she pointed out, when one looks at hiring a physicist, one rewards the qualities that reflect the inner picture and discounts those that are different—such as preferring male candidates over females. Such behavior, however unintentional, results in the accumulation of small advantages for the career of the male over time. It also perpetuates the original schema so that change continues to be difficult.

Alice Agogino of the University of California at Berkeley noted several examples where universities with strong leadership, motivated towards recruiting and promoting women, did quite well with their hiring rates for a few years and then performed poorly after a leadership change. She also noted that search committees that included a graduate student were more successful at hiring women and under-represented minorities than committees without students, suggesting that there is a generational gap as well as a gender gap.

Part of the problem may be the way in which data has previously been presented. As one attendee put it, the most valuable part of the workshop was that it "put the issues into scientific terms," from the "scope of the problem" to the statistics gathered and analyzed. However, there was also some indication of a more general lack of awareness. For instance, the University of Michigan Center for Research on Learning

“Dual-career couples represent a challenge to departments seeking to enhance the representation of women among their faculty, and it is very much in the interests of departments to identify and implement effective responses to that challenge.”

Laurie McNeil, University of North Carolina Chapel Hill

and Teaching's (CRLT) skit drew mixed reviews that ranged from "this is old news" and "it may have applied to my department 30-40 years ago," to a sardonic assertion that the audience "would not recognize themselves" in the biased characters portrayed in the skit (one attendee noted that some of these behaviors were observed at the conference the very next day). The CRLT performs skits highlighting issues of gender bias in common work situations. Their strategy is to engage the audience in discussions of biases and institutional climate. The performance simulated a faculty/scientists meeting in which a hiring search committee made its recommendations. The skit exposed several issues, such as the marginalization of senior women faculty and differences in expectations used to describe male versus female candidates. After the presentation, Director Jeffrey Steiger held an interactive discussion with the audience and players, who stayed in character. Based on the post-workshop evaluation of the performance, many attendees felt that it was an eye-opener on issues they are not aware of when involved personally in these situations. But many also did not feel the

careers had achieved tenure, while 77% of men reached tenure. Of women with no children or who had their children late, 65% had reached tenure after 14 years. Conversely, 47% of women who had their children early held second-tier positions while only 23% of men did. Other statistics show that among faculty, men are far more likely to be married with children and women are far more likely to be single without children. As mentioned earlier, having children or desiring to have children was one of several major deciding factors in women leaving academia after their PhD.

Mason added that several institutions, including Berkeley, have instituted a number of family-friendly initiatives for ladder-rank faculty. Berkeley also provides several resources for graduate students who are parents, and many other institutions are doing the same. Although women are likely to have children during the tenure years, they often do not use the family-friendly policies for fear it would hurt their chances for tenure.

Most workers perceive that there is workplace bias against caregivers[13], and thus use techniques of what



“We will not achieve gender equity in the academy until we confront—and conquer—biases against caregiving.”

Robert Drago, Penn State

Bob Drago, (Penn State University) informing the audience about “Bias Against Caregiving in the Academic Workplace: Evidence and Implications.”

issues were relevant any longer.

So, in fact, what do the data show? For one thing, they show that the extraordinary demands of achieving the top ranks of academia are in strong conflict with meeting the needs of young children, a load that disproportionately is borne by women, but one that concerns men as well. Social scientist Mary Ann Mason presented data on the disproportionate effect that motherhood has on a professional woman's career. Mason is Dean of the Graduate Division at the University of California, Berkeley, and also runs the “Do Babies Matter” project[14]. She has researched the effects that family responsibilities have on women's careers in a number of professions, including law, academia, the media, and science. Statistics from the University of California system show that during the 14 years after receiving the PhD, 53% of women who had children relatively early in their

Robert Drago of Penn State University called “bias avoidance” to evade the consequences. They may use productive bias avoidance techniques (staying single, delaying children, limiting family size) and/or unproductive bias avoidance (not taking a reduced work load, returning to work too soon after childbirth, skipping the children's games or functions). Regardless, bias avoidance more frequently affects more women than men.

Other subtle biases, no matter how unintentional, can poison a department's climate for women and minorities, too. These biases can crop up in many different areas, from stray remarks during faculty meetings, as mentioned by APS's Judy Franz, to heavier teaching loads[4], lack of opportunity for research, and lack of recognition—the latter two conclusions growing out of both break-out session discussions and the CRLT skit. As Virginia Valian pointed out earlier, a small amount of bias, accumulated over time, can result in a large amount of inequity.

A combination of biased schemas put women at a dis-

REPORT

“The voices of male heads of science or engineering departments can carry great weight in moving forward an institutional change agenda, especially if they use their access to institutional leaders and personal prestige to make the case for gender equity.”

Patricia Hyer, Virginia Tech

advantage during promotion and tenure evaluations. For instance, Valian demonstrated that there is often a subtle difference between how letters of recommendation are written for male versus female applicants: letters for males contain standard adjectives, while letters for women use grindstone adjectives such as “perseverance.” Letters for women also tend to contain more doubt-raising phrases, such as “challenging personality” or “excels at tasks of her own choosing.” Valian also noted that search committees often pay close attention to letters because it’s easy. However, if subtle biases are to be taken into account, the entire application package should be considered just as closely. Educating chairs and faculty to not stigmatize those who “stop the tenure clock” or make use of other family-friendly policies will improve the productivity of departments and make the hiring process more equitable.

Howard Georgi of Harvard University is well known for his support and mentoring of women students, and he described the steps Harvard has taken to increase women’s presence in academic physics. When he began breaking down the results of student satisfaction surveys by gender, he discovered all of the very dissatisfied respondents were female while all of the very satisfied students were male. Taking his female student’s perceptions seriously, he began

meeting with them, and he believes that this is crucial to maintaining a good climate in the department. Action is also required. In Harvard’s case, the discussions led to improving the quality of undergraduate classes, promoting departmental social functions, meeting regularly with women students, and encouraging study groups and places for students to work together. Georgi suggested that the best thing that a physics department chair could do to improve the experience of both male and female students is to become a feminist; improving conditions for one gender often improves them for both.

Judy Franz of APS said during the workshop, “If you make all your women students and faculty feel more valued by your speech and actions—including speaking up for family-friendly practices—and if you publicly chastise those who make snide comments, you will find the rewards are great.”

All the Best Minds: Recruiting and Retaining the Next Generation of Women, Minorities, and Men

Eliminating or even merely lessening bias will benefit everyone; that will allow the cream to rise to the top, regardless of gender, race, or ethnicity, and everyone will have a chance to reach their full potential. Once bias is recognized, how do institutions go about countering it? Two areas in which to



Participants are brainstorming during a breakout sessions about how best to handle specific recruitment, retention and promotion situations.



Panel discussion about training the next generation of physicists. Moderator, Meg Urry (Yale University). Panelists: Barbara Whitten (Colorado College) and Howard Georgi (Harvard University).

take action were agreed upon at the conference: recruitment and retention—fixing the leaking pipeline. When it comes to attracting more women and minorities to physics, both a climate and culture change may be necessary. This involves not just new programs and services to address women's concerns, but a rethinking of how physics is actually done—not the science, but the expectations and demands surrounding the work itself. Leadership in this effort needs to come from the top: academic department heads, research division heads, principal investigators, lab directors, and degree-granting institutions. The first step is making physics attractive to new students.

Recruiting Students, Faculty, and Staff

Alice Hogan, a program officer of NSF's Social, Behavioral, and Economic Sciences Directorate, asserted that demystifying physics is crucial. She said that if the field appears to be inaccessible, parents and guidance counselors will not encourage their children to enter it. This means reaching out to high schools and the public, rewarding good teaching, and supporting well-written popularizations written for general audiences. Often, physicists must wait until they have the luxury of tenure to write for the general populace. The new media have opened a breathtakingly broad conduit for reaching potential physics students. Encouraging untenured postdocs to balance research with science communica-

tion is one way to recruit the next generation of students.

Girls who have studied physics in high school are significantly less likely to select physics as a major than the boys in their classes. This is the biggest challenge we face in trying to increase the number of women who ultimately receive physics degrees. To address student issues, a panel consisting of Barbara Whitten, Howard Georgi, Mark Kastner of MIT (his presentation was given by Meg Urry of Yale University, as Kastner was unable to attend), and Keivan Stassun of Vanderbilt University, was specially designed to focus on identifying best practices for creating a friendly and supportive climate for students, and for encouraging success for women and minorities. Among the strategies the panel recommended was that physics department chairs should pay particular attention to the quality of the introductory courses as a recruitment tool and reward good undergraduate instructors to encourage better teaching.

Simply improving the community spirit in the department by encouraging teamwork is both effective for teaching physics and for building a sense of competence. Mark Kastner's presentation discussed the steps the MIT physics department has taken to grow and maintain a strong community of women students. These include a dedicated lounge area and an alumni-funded social program, and the active mentoring of women undergraduates by women graduate students. Similarly, Barbara Whitten maintained that using undergraduate students in K-12 outreach programs allows them to see themselves as members of the wider physics community and as potential role models. In addition, these undergraduate majors can help with recruiting at high schools to increase the number of female majors. Overall, the panel participants concluded that a department that has a good environment for women students improves retention for all students.

Of particular interest is an innovative program developed by Keivan Stassun at Vanderbilt University that teams with nearby Fisk University to share resources and support more women and minorities. Stassun pointed out that historically black colleges such as Fisk produce 50% of the African-American science, technology, and engineering graduates in the US. They also have a particularly high success rate

“The demographic changes to occur in the U.S. over the next half century make it vital that we increase the participation of women and under-represented minorities in physics, as well as all other scientific and technological fields.”

Artie Bienenstock, Stanford University, APS President

REPORT



Panel discussion featuring NSF and DOE funding agency officials. Moderator, Nora Berrah (Western Michigan University). Panelists: Judith Sunley, Executive Officer, NSF Directorate for Mathematical and Physical Sciences and Patricia Dehmer, Associate Director of Science for Basic Energy Sciences and Acting Deputy for Programs, DOE Office of Science.

for graduating women physics students. The Vanderbilt-Fisk Bridge Program allows master's degree students in physics and astronomy at Fisk to engage in research and to move easily into the doctoral program at Vanderbilt. These students receive full funding for their graduate work at both institutions. Advising and mentoring are done jointly by the two schools, and enrollees experience a fast-track into the research program at Vanderbilt. Of the 18 students currently enrolled in the program, half are women.

Having female leadership visible to incoming students, especially in the labs, is equally important, and that means recruiting female faculty and researchers, as several speakers, including Whitten, asserted. In another presentation, Natalie Roe of Lawrence Berkley National Laboratory suggested that broadly scoped job descriptions attract more women candidates. Mildred Dresselhaus of MIT added that special attention to dual-career couple issues during the recruitment process will also be attractive. One way to address the problem of employing the spouse/partner, Laurie McNeil added, is by pooling opportunities with other area colleges and universities. Universities and research labs can do more to make their employment more attractive to women by addressing the lifestyle issues of caregiving that affect them disproportionately. Is there a maternity policy for graduate students? Is there paid maternity leave for faculty and staff? Is there a "stop the tenure clock" option for those who wish to start a family or need to take care of ill family members during the tenure process? Are the hours flexible? Is there a mentoring or a career development program? These were some of the policy changes suggested at the workshop by participants Mary Ann Mason, Robert Drago, and Patricia Falcone of Sandia National Laboratories. Kastner in his presentation pointed out that MIT, for instance, has an eight-week maternity accommodation with pay for

women graduate students, funded by an insurance pool so that the cost is not charged to the department. MIT also offers a faculty development program for women postdocs and early career faculty to encourage successful academic careers for women.

Promoting Change

Change isn't easy; Patricia Hyer of Virginia Tech reminded the participants that it is most likely to occur when a variety of interdependent organizations—universities, research laboratories, and funding agencies, for example—share a sense of urgency and commitment to an agenda for action. Change within a department takes the cooperation of the whole university, as Mary Ann Mason pointed out in her presentation about strategies implemented at the University of California, Berkeley. To update their policies concerning hiring and retention, they developed a set of progressive new policies over the course of three years. With the support of the university president, they used research findings to propose changes in these policies before the academic senate, the chancellor, and provost—the whole chain of command. After much discussion and hammering out of issues, they created a chairs' and deans' toolkit^[20] with information on legalities and bias to help change the culture.

These are certainly positive steps. Policies alone are not enough, however. As Robert Drago of Penn State University noted, these policies must be widely advertised, and the people who need them must be reassured that their careers will not be penalized if they take advantage of them. Not only do chairs need to know what university packages are available in order to inform candidates and stay competitive, they need to encourage those already in the department, especially men, to take advantage of them. If only women take advantage of such programs, they will fear being stigmatized for doing so. Supportive supervisors were a big factor in decreasing

“Sandia has had success increasing the numbers and roles of technical women by a sustained, deliberate, and reviewed application of many of the strategies described at the workshop. Over time, we have improved the numbers of and roles for technical women as well as the overall climate of the workplace.”

Patricia Falcone, Sandia National Laboratories

women's unproductive bias avoidance, most particularly in the area of utilizing family-friendly work-life practices. He encouraged people to be honest and open about their care-giving needs in order to change the culture, and especially for men to trumpet their own care-giving activities, a task that he referred to as “using the Daddy Pulpit.” This type of culture change takes a long time until the change becomes the norm, and it does not happen without encouragement.

Search committees must be cognizant of and vigilant against bias when they review candidates. For this they need training in diversity issues. For example, Myron Campbell of the University of Michigan suggested that search committee members can be given specific training in reading letters of recommendation so that unintentional gender bias in the letters can be discounted. They should also learn to be sensitive to character and/or field assassination that can crop up in discussions of candidates—especially where male traits are viewed positively while female traits are seen as detracting from the value of the applicant. Including personnel from other academic departments or divisions of the laboratory on the search committee is also beneficial. Equally important is developing skills in doing in-person interviews. Interviewers should be aware of what types of questions are both inappropriate and biased and sometimes illegal—such as inquiring about marital status or children before hiring—or simply irrelevant to a candidate's qualifications. Following up on rejected offers by finding out the reasons for the rejection can provide valuable feedback to the committee.

Hiring more women and involving them in the search committee process can lead to positive results not

just at universities, but also at laboratories. Patricia Falcone described the situation at Sandia National Laboratories for women, who have been a part of the scene at all levels for some time. Sandia has created a number of intervention programs (support of outreach and in-reach activities, use of available family-friendly policies, mentoring, diversity trainings, etc.) to help retain women. Although women technical staff members enjoy successful and productive careers, the numbers of women are still not where Sandia's leadership would like them to be. Sandia recognizes that most women and men value flexible hours, and accommodating this need will be another means of increasing retention. Mentoring and networking, and establishing and communicating effective policies and establishing best practices for personal support can all help give physics a more welcoming climate for women.

Funding agencies are concerned with the recruitment and retention of women in physics and offer aid in the form of planning grants and programs. Patricia Rankin of the University of Colorado outlined lessons learned from her experience with the Leadership Education for Advancement and Promotion (LEAP) project, which is funded by NSF's ADVANCE program. The ADVANCE programs look at



Panel discussion about concerns and findings relevant to funding agencies with NSF and DOE directors. Moderator, Arthur Bienenstock (Stanford University) Panelists: Eric Rohlfling, Director, DOE Chemical Sciences, Geosciences, and Biosciences Division; Joseph Dehmer, Director, NSF Physics Division; W. Lance Haworth, Director, NSF Materials Research Division; G. Wayne Van Citters, Director, NSF Division of Astronomical Sciences.

REPORT

institutional barriers and 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 science and engineering workforce. The ADVANCE-supported LEAP project stresses institutional change at many levels and from many directions. For instance, workshops for women in which they improve their negotiating, networking, and communication skills are crucial, but so is commitment to institutional improvement by senior management. There must also be consequences for negative, biased behavior as well as recognition for women's work; the environment must be supportive for positive efforts to be successful.

The NSF itself has changed over the past 25 years, since there are now women across the divisions and disciplines. Judith Sunley, the Executive Officer of the NSF Directorate for Mathematics and Physical Sciences, pointed out that the agency now sponsors programs such as the ADVANCE grants. The NSF and other funding agencies are interested in collecting statistics on the breakdown of the diversity of personnel supported by their grants, but these data are provided only sporadically by grantees on a voluntary basis. Sunley called for an effort to capture more of this information from grantees, to improve the grant application process and make it friendly to diverse populations, especially those with family responsibilities.

Plugging the Leaks: Keeping Women in the Pipeline

Doctoral students, especially women, continue to turn away from careers their advisors have. One physics chair noted, "The students see their professors working very long hours to meet all of the demands of academic and research physics, and that, frankly, is not a very attractive life that we are trying to sell." He added that physics careers must leave the 19th century model in order to attract more students of all races and ethnicities and both genders to the field. Students hear a lot of grumbling and see their advisors working long hours, but they are not seeing or hearing the positive aspects of the jobs. Physics faculty, particularly women, need to let students know that careers in physics are great. They also need to know that the old work model of overlong hours precluding family life is changing.

Mildred Dresselhaus of MIT pointed out that improvements in the process of recruitment, mentoring and promotion are beneficial to all employees, but will have an

especially big impact on under-represented groups. Increased transparency surrounding the promotion process makes it less open to misunderstandings or misinterpretation, as well as making planning simpler and the task less daunting.

For example, the NSF's Alice Hogan mentioned that men often make use of informal mentoring networks. For women who frequently do not have access to such informal networks, formal mentoring programs are critical. Just gathering women faculty and doctoral students for lunch or dinner creates camaraderie and ensures that women in science know each other well enough to create a sense of community.

Likewise, G. Wayne Van Citters, Director, NSF Division of Astronomical Sciences, suggested that teaching graduate students about the grant process by involving them in the writing and bringing postdocs to grant reviews will make the monetary side of the research process less mysterious and challenging. It will also allow them to begin building their own networks for future grants. A suggestion from the audience was that expanding program officers' travel budgets so they can travel to conferences to meet prospective grant applicants would also ease the process, as would the addition of more female program managers.

Patricia Hyer, in one of the workshop's last sessions, suggested several ways to promote institutional changes. These include:

- ▶ Identify likely allies and invite them to lunch;
- ▶ Use the leverage YOU have to help OTHERS make the case;
- ▶ Find the language and rationale that works on your campus;
- ▶ Help pull together what your campus is already doing; and
- ▶ Borrow liberally from others, but adapt, and make it your own.

She ended her presentation with a challenge, saying: "You can make a powerful difference in your own organizational unit by adopting proactive policies and practices; and you can lend your voice, stories you know of, and your prestige to the initiative, becoming an ally for others. These are important contributions in any culture change."

GENDER EQUITY

3

CONCLUSIONS

The scientific lifestyle we read about in biographies of scientists in the 1920s (which included vacations in the Alps where scientists spent their time brainstorming and thinking creative thoughts) is much more appealing than the 24/7 lifestyle that is promoted today as a way to succeed. A number of faculty mentioned that their students explicitly tell them, “I don’t want a life like yours.” Physics as a career will be more attractive to all participants—women, men, and under-represented minorities—if students perceive that being a successfully funded researcher does not preclude having a life that includes family, friends, and time for pursuing personal interests. Changes in the present culture are a must. APS-CSWP site visits can be effective to inform departments/units about their specific climate, enabling them to recognize/improve the culture and mindset present in their department or laboratory.

Academic jobs in the physical sciences are seen as demanding careers—people will be discouraged from entering physics if it looks like the opportunities to pursue a career are limited. Funding agencies need to be an integral part of the transformation that will be necessary to make physics an attractive career option for the under-represented population. In return for their investments, the nation will benefit from the world-leading science and technology that an exceptional and diverse workforce produces. Deliberate investment in funding new programs, as well as continuing and expanding existing programs, can have a significant impact on attracting and retaining women in physics and ensuring that the nation benefits from an expanded talent pool.

This report is intended for all physics organizations. The active participation of physics department chairs, national laboratory managers, and federal agencies in the workshop allowed collective work that enabled new ideas to emerge, both to make the field of physics more attractive to women and men and to find effective ways to retain women in physics. The post-workshop goal is for all physics department chairs and national laboratory managers to use this report to become “change agents.” This can be achieved by working with their faculty members and scientists and by communicating to them the best practices and action items that were produced at the workshop.

A follow-up workshop is planned in 2009 to assess the progress made toward the goal of doubling the number of women in 15 years.

“Women are dramatically under-represented among the faculty of academic Materials Science and Engineering departments—and in Colleges of Engineering generally—just as they are in the physical sciences. My take-home message from an interdisciplinary perspective is that we must extend these initial efforts beyond the physics and chemistry communities to address the gender equity challenge even more broadly. Engineers, awake!”

W. Lance Haworth,
National Science Foundation

GENDER EQUITY

4

REFERENCES

1. Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future, National Academies Press (2007). www.nap.edu/catalog/11463.html
2. Academic Workforce Survey, 2006, American Institute of Physics, (in press).
3. A National Analysis of Minorities in Science and Engineering Faculties at Research Universities, D. Nelson, Norman, OK, October 2007. cheminfo.chem.ou.edu/~djn/diversity/Faculty_Tables_FY07/07Report.pdf
4. Workshop report by the chemistry community on Workshop on Building Strong Academic Chemistry Departments through Gender Equity (2006) and references therein. www.chem.harvard.edu/groups/friend/GenderEquityWorkshop/GenderEquity.pdf.
5. P. Mulvey and S. Nicholson, Enrollments and Degrees Report, 2005, AIP Pub. R-151.42 (2007). www.aip.org/statistics/trends/reports/ed.pdf
6. Education in Nuclear Science, A report to the DOE/NSF Nuclear Science Advisory Committee, p 4-15 (November 2004), 1. www.sc.doe.gov/henp/np/nsac/docs/NSAC_CR_education_report_final.pdf
7. R. Ivie and K. Nies Ray, Women in Physics and Astronomy 2005, American Institute of Physics, and references therein. Table contains data from this report as well as unpublished (2006) data from AIP (private communication). www.aip.org/statistics/trends/reports/women05.pdf
8. Editors B. K. Hartline and A. Michelman-Ribeiro, Women in Physics, 2nd IUPAP international conference on women in physics, Rio de Janeiro, Brazil, May 23-25, 2005, AIP Conference Proceedings, 795, and references therein. proceedings.aip.org/proceedings/confproceed/795.jsp
9. Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering, National Academy of Sciences, National Academy of Engineering and Institute of Medicine (2007) and references therein. books.nap.edu/openbook.php?isbn=0309100429
10. Virginia Valian, Why So Slow? The Advancement of Women, MIT Press, 1999.
11. Women, Minorities, and Persons with Disabilities in Science and Engineering: 2004, National Science Foundation, Division of Science Resources Statistics, NSF 04-317, Arlington, VA, 2004.
12. L. McNeil and M. Sher, "The Dual-Career-Couple Problem," Physics Today 52, 32-37 (July 1999).
13. C. Colbeck and R. Drago, "Accept, Avoid, Resist: Faculty Members' Responses to Bias Against Caregiving... and How Departments Can Help," Change: The Magazine of Higher Learning, 37, 10 (2005) www.carnegiefoundation.org/change/sub.asp?key=97&subkey=829; R. Drago, C. Colbeck, K. D. Stauffer, A. Pirretti, K. Burkum, J. Fazioli, G. Lazarro and T. Habasevich; "Bias Against Caregiving," Academe 91, 22-25 (2005). www.aaup.org/AAUP/pubsres/academe/2005/SO/Feat/drag.htm
14. M. A. Mason and M. Goulden, "Do Babies Matter (Part II)? Closing the Baby Gap", Academe, 90, 3-7 (2004) www.aaup.org/AAUP/pubsres/academe/2004/ND/Feat/04ndmaso.htm; M. A. Mason, and M. Goulden, "Marriage and Baby Blues: Re-defining Gender Equity in the Academy", The Annals of the American Academy of Political and Social Science, 596, 36-61 (2004); M. A. Mason and M. Goulden, "Do Babies Matter? The Effect of Family Formation on the Lifelong Careers of Academic Men and Women", Academe, 88, 21-27 (2002) www.aaup.org/AAUP/pubsres/academe/2002/ND/Feat/Maso.htm.

REFERENCES

15. M. Murnane, "Best Practices," CSWP Gazette 2003.
www.aps.org/programs/women/reports/bestpractices
 16. M. Urry, "Speeding up the long slow path to change," APS News, The Back Page, Feb 2003.
www.aps.org/publications/apsnews/200302/backpage.cfm
 17. Ensuring a Strong U.S. Scientific, Technical and Engineering Workforce in the 21st Century, National Science and Technology Council, April 2000.
www.ostp.gov/pdf/workforcerpt.pdf
 18. National Center for Education Statistics, Integrated Post Secondary Educations System (IPEDS). webcaspar.nsf.gov Relevant data extracted from this database available from Theodore Hodapp (hodapp@aps.org).
 19. J. Stockard, A Gender Equity Conference For Heads of Departments and National Labs of Physics: Analysis of Pre-Conference and Post-Conference Data, unpublished, available on request from the author: Jean Stockard, Professor Emeritus, Department of Planning, Public Policy, and Management, University of Oregon, Eugene, Oregon 97403.
[20. ucfamilyedge.berkeley.edu/toolkit.html](http://20.ucfamilyedge.berkeley.edu/toolkit.html)
- Additional resources**
- Conference Website
www.aps.org/programs/women/workshops/gender-equity
- Committee on the Status of Women in Physics – Links and Resources, links to reports, articles, associations.
www.aps.org/programs/women
- APS "Female-Friendly" web site. Self reported data from nearly every graduate school in the United States on issues relevant to women.
www.aps.org/programs/women/female-friendly
- A collection of data and reports on women in physics from the American Institute of Physics Statistical Research Division.
www.aip.org/statistics/trends/gendertrends.html
- Recruitment and Retention of Female Graduate Students: What Have We Learned from the APS Climate for Women Site Visit Program? Laurie E. McNeil, Dept. of Physics and Astronomy, Univ. of North Carolina at Chapel Hill
www.physics.unc.edu/~mcneil/MM04_files/frame.htm
- References on Chilly Climate for Women Faculty in Academia
dynamic.uoregon.edu/~jjf/chillyclimate.html
- Academic Climate: Addressing the Climate for Women in Academia
www.chillyclimate.org
- Website: Dual Science-Career-Couples
www.physics.wm.edu/dualcareer.html
- C. M. Henry, "Improving the Postdoc," Chemical & Engineering News, 82, 47-48 (2004)
pubs.acs.org/email/cen/html/021904101943.html
- Resources from AIP's website with advice and data on graduate schools
www.gradschoolshopper.com/resources.jsp#gradadvice
- M. Olmstead, "Mentoring New Faculty: Advice to Department Chairs," CSWP Gazette, 13, 1 (1993)
faculty.washington.edu/olmstd/research/Mentoring.html
- E. Culotta, "Study: Male Scientist Publish More, Women Cited More," The Scientist 7, 14 (1993)
www.the-scientist.com/article/display/16183/

GENDER EQUITY

5

WORKSHOP SCHEDULE

Sunday Evening, 6 May 2007

- 4:30 P.M. Reception with Hors d'Oeuvres
- 6:00 P.M. **Opening Remarks, Introductions, and Goals of the Workshop**
 Co-Chair, Arthur Bienenstock, *Stanford University*
 Co-Chair, Nora Berrah, *Western Michigan University*
 Tony Chan, Assistant Director, *NSF Directorate for Mathematical and Physical Sciences*
 Patricia Dehmer, Associate Director of Science for Basic Energy Sciences and Acting Deputy for Programs, *DOE Office of Science*

Session 1: Defining the Issues

Presiding: Arthur Bienenstock, *Stanford University*

- 6:15 P.M. **Beyond Bias and Barriers: Fulfilling the Potential of Women In Academic Science and Engineering**
 Keynote Speaker: Alice Agogino
University of California Berkeley
- 6:45 P.M. **Discussion**
 Presiding: Nora Berrah
Western Michigan University
- 7:00 P.M. **The Nation Needs More Women Physicists**
 Speaker: Arthur Bienenstock, *Stanford University*
- 7:30 P.M. **Discussion**
- 7:45 P.M. **University of Michigan CRLT Players Theatre Performance** Sketches Will Visually Demonstrate Biases In the Context of Mentoring, Hiring, and Tenure Decision Processes
- 9:00 P.M. Reception With Hors d'Oeuvres

Monday, 7 May 2007

Session 2: Equity and Bias

Presiding: Theodore Hodapp, *American Physical Society*

- 8:00 A.M. **Why So Slow?**
The Advancement of Women In Science
 Keynote Speaker: Virginia Valian, *Hunter College*

- 8:30 A.M. **Discussion**

- 8:45 A.M. **Do Babies Matter In Scientific Careers? The Case For Changing the Culture**
 Mary Ann Mason, *University of California Berkeley*

- 9:15 A.M. **Discussion**

- 9:30 A.M. **Break**

Session 3: Challenges and Opportunities

Presiding: Meg Urry, *Yale University*

- 10:00 A.M. **Bias Against Caregiving In the Academic Workplace: Evidence and Implications**
 Keynote Speaker: Robert Drago,
Penn State University
- 10:30 A.M. **Discussion**
- 10:45 A.M. **Panel Discussion: Challenges To Institutions; Recruitment and Hiring, Retention and Promotion**
 Moderator: Ana Mari Cauce, *University of Washington*
 Panelists: Pat Falcone, *Sandia National Laboratories*
 Myron Campbell, *University of Michigan*
 Millie Dresselhaus, *MIT*
 Mary Ann Mason, *University of California Berkeley*

Session 4: Recommendations to Increase Recruitment, Hiring, Retention and Promotion

Presiding: Sherry Yennello, *Texas A&M University*

- 12:15 P.M. **Breakout Sessions A: (Working Lunch Provided)**
 Eight groups will meet, each charged with identifying challenges that departments/divisions face in working towards eliminating biases that negatively impact efforts to recruit, hire, retain, and promote women in physics. Groups will develop a set of best practices and recommendations that will increase the recruitment, retention, and promotion of women in physics. The leader of each group or designated reporter will make a brief report to the whole meeting.

- 2:00 P.M. **Summary of Breakout Session A**

WORKSHOP PARTICIPANTS

2:30 P.M. Panel Discussion: Recommendations from Panel A
 Moderator: Karan Watson, *Texas A&M University*
 Panelists: Laurie McNeil, *University of North Carolina, Chapel Hill*
 Patricia Rankin, *University of Colorado*
 Sue Rosser, *Georgia Tech*
 Natalie Roe, *Lawrence Berkeley National Laboratory*

4:00 P.M. Break

**Session 5:
 Training the Next Generation**
 Presiding: Catherine Fiore, MIT

4:30 P.M. Panel Discussion: Identifying and Implementing Best Practices For Eliminating Biases That Negatively Impact Efforts To Recruit, Hire, Retain, and Promote Students and Postdocs In Physics
 Moderator: Meg Urry, *Yale University*
 Panelists: Barbara Whitten, *Colorado College*
 Howard Georgi, *Harvard University*
 Marc Kastner, *Massachusetts Institute of Technology*
 Keivan Stassun, *Vanderbilt University*

6:00 P.M. Reception

7:00 P.M. Dinner

Tuesday, 8 May 2007

**Session 6:
 Challenges and Opportunities At Funding Agencies, Presiding: Nora Berrah (WMU)**

8:00 A.M. Remarks and Panel Discussion Featuring NSF and DOE Funding Agency Officials
 Patricia Dehmer, *Associate Director of Science for Basic Energy Sciences and Acting Deputy for Programs, DOE office of Science*
 Judith Sunley, *Executive Officer, NSF Directorate for Mathematical and Physical Sciences*

8:20 A.M. Discussion

8:35 A.M. Panel Discussion: Special Programs
 Panelists: Judy Franz, *Executive Officer American Physical Society*
 Alice Hogan, *Program Officer, NSF Social, Behavioral, and Economic Sciences Directorate*
 Sharon Wyatt, *Attorney-Advisor DOE Office of Civil Rights & Diversity*
 Patricia Hyer, *Virginia Tech*

9:45 A.M. Break
 Presiding: Patricia Rankin, *University of Colorado*

10:15 A.M. Breakout Sessions B: Recommendations to Funding Agencies
 Eight breakout sessions with groups discussing issues relevant to DOE and NSF funding. Breakout group assignments do not change.

11:15 A.M. Reports from Breakout Group Leaders

11:45 A.M. Panel Discussion: Issues and Findings Relevant To Funding Agencies
 Moderator: Arthur Bienenstock, *Stanford University*
 Panelists: Eric Rohlffing, *Director, DOE Chemical Sciences, Geosciences, and Biosciences Division*
 Beverly J. Berger, *Director, DOE National Nuclear Security Administration University Partnerships Division*
 Joseph Dehmer, *Director, NSF Physics Division*
 W. Lance Haworth, *Director, NSF Materials Research Division*
 G. Wayne Van Citters, *Director, NSF Division of Astronomical Sciences*

12:45 P.M. Summary of Breakout Sessions B

1:15 P.M. Concluding Remarks: Co-Chairs

1:30 P.M. Lunch

2:15 P.M. Open Session For the Press and Public Summarizing the Results of the Workshop

GENDER EQUITY

6

WORKSHOP PARTICIPANTS

Carol Adkins

Sandia National Laboratories

Deb Agarwal

Lawrence Berkeley National Laboratory

Alice Agogino

University of California, Berkeley

Philip Allen

SUNY, Stony Brook

Meghan Anzelc

Forum on Graduate Student Affairs

Andrew Baden

University of Maryland, College Park

Jonathan Bagger

Johns Hopkins University

Anjuli Bamzai

Department of Energy

Jayanth Banavar

Pennsylvania State University

Wolfgang Bauer

Michigan State University

Dave Belanger

University of California, Santa Cruz

Kristin Bennett

Department of Energy

Beverly J. Berger

Department of Energy

Nora Berrah

Western Michigan University

Arthur Bienenstock

Stanford University

Linda Blevins

Department of Energy

Ari Bodek

University of Rochester

Marsha Bollinger

Department of Energy

Tammy Bosler

National Science Foundation

Myron Campbell

University of Michigan, Ann Arbor

Allison Campbell

Pacific Northwest National Laboratory

Michael Casassa

Department of Energy

Ana Mari Cauce

University of Washington

Christine Chalk

Department of Energy

Tony Chan

National Science Foundation

Shirley Chiang

University of California, Davis

Mei-Yin Chou

Georgia Institute of Technology

Sid Coon

Department of Energy

George W. Crabtree

Argonne National Laboratory

John Cumalat

University of Colorado, Boulder

Jessie DeAro

National Science Foundation

Patricia Dehmer

Department of Energy

Joseph Dehmer

National Science Foundation

Susan Deustua

American Astronomical Society

Catherine Didion

National Academy of Sciences

Ryan Doezeema

University of Oklahoma

Alan Dorsey

University of Florida

Robert Drago

Penn State University

WORKSHOP PARTICIPANTS

Millie Dresselhaus
Massachusetts Institute of Technology

Daniel Dubin
University of California, San Diego

Steve Eckstrand
Department of Energy

Patricia Falcone
Sandia National Laboratories

Manouchehr Farkhondeh
Department of Energy

Catherine Fiore
Massachusetts Institute of Technology

Ray Fonck
Department of Energy

Judy Franz
American Physical Society

Don Freeburn
Department of Energy

Edward Fry
Texas A&M University, College Station

Wendy Fuller-Mora
National Science Foundation

Howard Georgi
Harvard University

Fred Gilman
Carnegie Mellon University

Bennett Goldberg
Boston University

William D. Gropp
Argonne National Laboratory

Beverly K. Hartline
APS Committee on Minorities

W. Lance Haworth
National Science Foundation

Blayne Heckel
University of Washington

Barb Helland
Department of Energy

Kenneth Heller
University of Minnesota

Andrew Hirsch
Purdue University, West Lafayette

Mary Y. Hockaday
Los Alamos National Laboratory

Theodore Hodapp
American Physical Society

Alice Hogan
National Science Foundation

Linda Horton
Oak Ridge National Laboratory

Patricia Hyer
Virginia Tech

Robert Joynt
University of Wisconsin, Madison

Mary Ann Juhas
National Science Foundation

Judith Kammeraad
Lawrence Livermore National Laboratory

Marc Kastner
Massachusetts Institute of Technology

Kenneth Kelton
Washington University

Dennis Kovar
Department of Energy

Andrew Lankford
University of California, Irvine

Dana Lehr
National Science Foundation

Kenneth Libbrecht
California Institute of Technology

Derek Lowenstein
Brookhaven National Laboratory

Tom C. Lubensky
University of Pennsylvania

David MacFarlane
Stanford Linear Accelerator Center

WORKSHOP PARTICIPANTS

Jonathan Machta
University of Massachusetts, Amherst

Janardhan Manickam
Princeton Plasma Physics Laboratory

John T. Markert
University of Texas, Austin

Darlene Markevich
Department of Energy

Daniel Marlow
Princeton University

Mary Ann Mason
University of California, Berkeley

Kathleen McCloud
National Science Foundation

Laurie McNeil
University of North Carolina

Andrew Millis
Columbia University

Robert Nemanich
Arizona State University

Cathie Newman-Holmes
Fermi National Accelerator Laboratory

Antonella Nota
STScI/ESA

Lynette Osborne
National Academy of Engineering

Michael Paesler
North Carolina State University

Ritchie Patterson
Cornell University

Lawrence Pinsky
University of Houston

Dinko Pocanic
University of Virginia

Walt Polansky
Department of Energy

Patricia Rankin
University of Colorado

Ian Robertson
University of Illinois, Urbana-Champaign

Natalie Roe
Lawrence Berkeley National Laboratory

Eric Rohlffing
Department of Energy

Celeste Rohlffing
National Science Foundation

Sue Rosser
Georgia Institute of Technology

Will Saam
Ohio State University

Alexander Sachs
University of Massachusetts, Lowell

Bernard Sadoulet
University of California, Berkeley

Joseph Scanio
University of Cincinnati

Ramamurti Shankar
Yale University

Dennis Skopik
Thomas Jefferson National, Accelerator Facility

Mark Srednicki
University of California, Santa Barbara

Robin Staffin
Department of Energy

Keivan Stassun
Vanderbilt University

Judith Sunley
National Science Foundation

Chung-I Tan
Brown University

Melville Ulmer
Northwestern University

Claudia Megan Urry
Yale University

Virginia Valian
Hunter College/CUNY Graduate Center

G. Wayne Van Citters
National Science Foundation

Dale Van Harlingen
University of Illinois, Urbana-Champaign

David Van Winkle
Florida State University

Bob Wald
University of Chicago

Karan Watson
Texas A&M University

Mitchell Wayne
University of Notre Dame

WORKSHOP PARTICIPANTS

Barbara Whitten

Colorado College

Theresa Windus

Department of Energy

Lindley Winslow

Forum on Graduate Student Affairs

Darien Wood

Northeastern University

Sharon Wyatt

Department of Energy

Sherry Yennello

Texas A&M University

Support for this conference has been received
from the Department of Energy and the National
Science Foundation

GENDER EQUITY

7

ACKNOWLEDGMENTS

This report describes the results of the conference “Gender Equity: Strengthening the Physics Enterprise in Universities and National Laboratories,” organized by the American Physical Society’s Committee on the Status of Women in Physics. The conference received substantial support from the National Science Foundation under Award PHY-0710948 and from the Department of Energy under Award DE-FG02-07ER15857. Particular thanks go to Nora Berrah, co-chair of the conference and lead author of this report; Arthur Bienenstock, co-chair of the conference; and to the Organizing Committee for their outstanding efforts. We also acknowledge the advice and support of funding agency representatives, Kathleen McCloud and Linda Blevins.

In addition, the Organizing Committee would like to thank Geri Richmond, University of Oregon, for useful discussions during the organization of this workshop as well as for providing assistance from the Committee of the Advancement of Women in Chemistry (COACH) infrastructure. We also wish to thank Priscilla Lewis, University of Oregon, for working on the pre- and post-survey, and Celeste Roling, NSF, for providing information about the Chemistry workshop. Finally we would like to thank Jean Stockard, University of Oregon, for analyzing the workshop pre-post survey data.

Finally, we wish to express our appreciation to the following American Physical Society staff members: Judy Franz, Executive officer; Theodore Hodapp, Director of Education and Diversity; Kerry G. Johnson, Art Director and Special Publications Manager and Krystal Ferguson, Special Publications Graphic Designer; and Ed Lee, Education and Outreach Program Manager, and Sue Otwell, Women and Education Programs Administrator, who contributed generously of their time and skills. Their assistance was invaluable.

Organizing Committee

Nora Berrah, Co-chair

Western Michigan University

Arthur Bienenstock, Co-chair

Stanford University

Kimberly Susan Budil

Lawrence Livermore National Laboratory

Catherine Fiore

Massachusetts Institute of Technology

Theodore Hodapp

American Physical Society

Patricia Rankin

University of Colorado

Claudia Megan Urry

Yale University

Sherry J. Yennello

Texas A&M University

Funding Agency Representatives

Beverly Kobre Berger

National Science Foundation

Tammy Bosler

National Science Foundation

Dana Lehr

National Science Foundation

Kathleen McCloud

National Science Foundation

Wendy Fuller Mora

National Science Foundation

Linda Blevins

US Department of Energy

Eric Rohlfing

US Department of Energy

APS Staff Liaison

Sue Otwell

Women & Education Programs Administrator

Publication Design

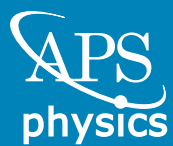
Krystal Ferguson

Special Publications Graphic Designer, APS

Kerry G. Johnson

Art Director & Special Publications Manager, APS





American Physical Society
One Physics Ellipse
College Park, MD 20740-3844