June 2001

STATUS

A REPORT ON WOMEN IN ASTRONOMY

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A Publication of the American Astronomical Society Committee on the Status of Women in Astronomy

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Andrea Dupree is a past president of the American Astronomical Society, a Senior Astrophysicist at the Smithsonian Astrophysical Observatory, and recently chaired the Astronomy Survey Committee Panel on Education and Public Policy.

Evaluation of the Status of Women in Astronomy

By Andrea Dupree

AT THE JANUARY 2001 meeting of the American Astronomical Society (AAS), Margaret Burbidge correctly noted that a great deal has changed for women in astronomy over the course of her own career. In theory at least, the doors to observatories are open to all, and that is indeed an accomplishment. But worrisome facts appear in today's statistics. While women have made progress in some areas, studies such as the Space Telescope Science Institute (STScI) faculty survey, the AAS survey, and the Massachusetts Institute of Technology (MIT) study of senior women faculty all present evidence that women are still struggling for equal treatment in the sciences.

Andrea Dupree

The surveys highlight two areas critical to professional advancement: the movement from graduate student to postdoctoral position, and the achievement of the highest professional level – the full professor level. At both these junctions, women are under-represented relative to their availability.

Evaluation of the status of women and minorities takes place in the context of a growing professional contingent of all astronomers in the United States. The 1999 Survey of

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Meg Urry does research on active galaxies, notably blazars. Until recently she headed the Science Program Selection Office at STScI; in July she will become Professor of Physics at Yale University and Director of the Yale Center for Astronomy and Astrophysics. She chairs the AAS Committee on the Status of Women in Astronomy and is a member of the Committee on the Status of Women in Physics of the American Physical Society. She has been co-editor of STATUS since 1998 (with Lisa Frattare).

Women in Science at U.S. Universities: Criticism and Defense of the MIT Report

By Meg Urry

Meg Urry

Summit of Nine Top Research Universities

AT THE END OF JANUARY 2001, leaders from nine top research universities convened at the Massachusetts Institute of Technology (MIT) to discuss the situation of women scientists at their institutions. This followed the famous "MIT Report," made public in March 1999, which described the disadvantages faced by very successful senior women scientists at MIT — lower salaries, less research space, little or no representation on key university committees, and so on. (See STATUS June 1999.)

MIT's admission two years ago that it had unintentionally discriminated against women was unprecedented. MIT president Charles M. Vest said in a letter prefacing the 1999 report, "I have always believed that contemporary gender discrimination within universities is part reality and part perception. True, but I now understand that reality is by far the greater part of the balance."

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Women in Astronomy carried out by the STScI[1] documented that the field of astronomy experienced a huge growth between the 1992 STScI Survey and 1999 - an overall 1/3 increase in the number of Ph.D. astronomers active in 32 US Departments of Astronomy and 4 observatories with equivalent science facilities.[2] With so many new jobs created and in an expanding market, there should be ample opportunity for equal access. What has actually taken place?

In the first instance, the STScI survey found that 58% of men progress from graduate school to a postdoctoral position at a comparable institution, but only 41% of the women Ph.D. graduates do likewise. Men are about 1.5 times as likely as women to make this first critical step in a professional career.

Why is this happening? It is neither logical nor persuasive that competitive schools select and graduate women to fill preferentially and consistently the lower ranks of their classes making women less attractive as postdoctoral material. Some other factor is at work. Are women consciously deciding to opt out of the postdoctoral experience for their own reasons? Or is this evidence of outright rejection for postdoctoral positions? After the graduate school experience, do women feel themselves not to be strong candidates for postdoctoral positions? Is this feeling subtly reinforced by faculty? Is a fear of failure lurking in the background? There are few or no data to answer such questions.

Certainly challenging, exciting, and satisfying opportunities are numerous outside of a "traditional" research/faculty career. And in many cases, the pay is much better too! Several of my male colleagues have left or refused faculty positions. A faculty position can actually be "a drag." Teaching at specified times year after year, competing for a summer salary, dealing with students who are marking time to fulfill requirements, working around the clock to make tenure, with committee or administrative requirements added on, may not produce a satisfying career. All of these activities can compete too with "a life."

Are women not selected for postdoctoral positions? My experience and review of several named postdoctoral fellowship programs shows that women quite frequently make the short list and selection in greater proportions than the gender division of the applicants. The majority of postdoctoral positions however are not the named fellowships; is it here that female candidates do not appear as scientifically strong? Are there subtleties in the recommendation letters that make them appear less worthy candidates? Or do women themselves decide that, for whatever reason, they prefer not to pursue a postdoctoral position? Perhaps their talents are used in a myriad of other technical or scientific fields, and that is fine. Perhaps they are attracted to something quite different. Everyone can make her own choice and selection of a life path. However, the postdoctoral statistics should raise deep concerns in all segments of our community. Losing the contributions of a substantial fraction of the next generation of accomplished women marks a loss of scientific discovery and progress regardless of reason.

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STATUS

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http://www.aas.org/~cswa/status

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The second problem is not a surprise. The literature of science careers well documents that professional women do not advance as fast as men, receive lower pay than men, and remain at lower ranks then men. This disparity does not appear to stem from marital status, child-bearing, mobility, or any of the sociological factors that might distinguish women from men in current society; rather, the prevailing model is that women suffer from the accumulation of smaller disadvantages, which cumulatively result in their taking longer to be promoted to tenure or to full professorship, being paid less compared to men with similar credentials, and being less well represented at the top echelons of scientific society.[3]

In astronomy, about three-quarters of the men on faculties are in full professor positions; whereas only about 43% of women currently hold that rank. In astronomy 5-6% of the senior positions are held by women. The lowered representation of women at the highest levels is mirrored also in the National Academy of Sciences.

Some have asserted that lack of women is a "pipeline problem." Now that more women are studying astronomy, they (eventually) should be represented through the ranks at all levels. But the statistics do not support that idea. Lack of senior women is not a recent phenomenon that will be improved when the "pipeline" catches up. The pool of availability to assess adequate representation is the Ph.D. production rate. We can go back as far as the 1920's and continue to the 1980's and the Ph.D. production in astronomy and astrophysics varied between 8 and 20%.[4]

Since then, the NSF tabulation shows that from 1980 through 1999, doctorates by year ranged from 10 to 20% women. The pipeline has been full for almost a century! Yet the fraction of women who are full professors is about 6%. The figures for women are always playing catch up. If there were truly gender blind appointments, if the selection were truly random - sometime, somewhere, women would exceed their availability in the pool. I have not found evidence that this has ever occurred. I suspect that search committees do not value women's research as equivalent to that of men and that biases are hidden. I also am concerned that such behavior and the chilly climate and inequities for women in academia (as has been demonstrated by the MIT study) discourage application for faculty positions.

> It is neither logical nor persuasive that competitive schools select and graduate women to fill preferentially and consistently the lower ranks of their classes making women less attractive as postdoctoral material.

What can be done about this state of affairs?

First, constant vigilance is needed to remind our colleagues that opportunities are not yet gender blind. We need current statistics to demonstrate that this continues as a real problem here and now. Frequently the issue of equal opportunity is dismissed with the statement: "your data are out of date; we have fixed that problem, it is no longer an issue." I have learned that data must be up to date; the statistics must be current. We are a scientific profession, and anecdotes don't carry the day. The AAS should continue their annual compilation of statistics of its members, and STScI is to be applauded for initiating and supporting two very helpful surveys.

• Demand open policies and procedures at your institute or department. Much goes on behind closed doors offering private opportunities for subjective decisions and 'rewards' to an inner circle of colleagues. The more that procedures themselves are available, options are brought into the sunlight, the better for everyone.

- Identify leaders who will support the issues that concern professional women. Experience shows that a leader determined to make change can influence that change enormously.
- Band together to make your case. Discuss issues with your colleagues; they undoubtedly have had similar experiences. The women faculty initiating the MIT study achieved their strength through shared experience. It is easier to dismiss a single person with a problem than a group with the same problem.

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- Speak out both loudly and frequently when egregious events occur. Not so long ago, in our observatory, a lovely, large, color poster appeared announcing a meeting and listing the speakers. Thirty-nine speakers were named of which 38 were men. Surely more than one woman was making contributions in this field. Even one (male) graduate student was listed as a speaker! Several senior women complained, loudly, and the speaker's list was modified. It is amazing to me and sad as well that such pressure was needed in this day and age. I think that agencies funding meetings should keep an eye out for an appropriate balance of speakers, just as they already do when funding participants. The CSWA Electronic Newsletter frequently receives scorecards with gender distribution of speakers. This is a good resource. Make sure that your local colloquium program is well balanced both in gender and science.

> Frequently the issue of equal opportunity is dismissed with the statement: "your data are out of date; we have fixed that problem, it is no longer an issue."

- Learn from success stories. An impressive effort was made in Johns Hopkins University School of Medicine to identify gender-based career obstacles for women and then to establish a number of interventions to correct these problems and improve career success and satisfaction of women faculty. These ranged from structural changes, to mentoring programs, to educating faculty, and actions to decrease isolation of women faculty. They even went so far as to reschedule a 100-year old tradition of holding medical Grand Rounds on Saturday morning to Friday morning. And the attendance of both men and women increased! The Johns Hopkins results are impressive, both in the numbers of women faculty they have retained and promoted, and in improving the climate for all faculty. Follow-up surveys to this long-term program demonstrated that men also felt the situation had improved for them. These procedures forcefully demonstrate that with motivation and strong administrative backing, that conditions can be improved for both men and women.[5] The NSF has initiated a cross-cutting program this year, dubbed ADVANCE, to support academic institutional transformation to promote increased participation and advancement of women scientists in academe. We need to keep apprised of the results of this new effort and adopt the successful strategies.

- Don't underestimate your effect as a role model. A most pleasant surprise for me has come from other women, now well known and accomplished in astronomy, recalling a lecture I gave or an article they read about me, way back in the early stages of their careers, or even before they had decided to enter astronomy. And I am told such contact made astronomy an interesting and appealing career, and gave them encouragement to continue. I know our days are overloaded with responsibilities and pressures, but take a moment now and then to share the challenge and joy of our profession with those just starting out. You may make a difference! ❖

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[1] CSWA, Weekly Electronic Issue 6/16/99; CSWA STATUS June 1999.

[2] The National Science Foundation noted (NSF 99-339, April 6, 1999) that the numbers of Ph.D. recipients in the United States have been declining between 1994-1997, physics is down by 11 percent; chemistry is down by 6 percent; however, astronomy is up by 37% to 197 Ph.D. degrees in 1997. The latest figures show that 160 Ph.D. degrees were awarded in academic year 1999 of which 20% went to women (http://caspar.nsf.gov).

[3] Valian, V. 1998, Why So Slow? The Advancement of Women, MIT Press.

[4] Doctorates Awarded from 1920 to 1971 by Subfield and doctorate, Sex, and Decade, National Research Council, March 1973; Doctorate Recipients from United States Universities Summary Reports, 1972-1984, National Research Council; tabulated in Professional Women and Minorities, Commission on Professionals in Science and Technology, 1986, p. 142.

[5] Career Development for Women in Academic Medicine, Fried, L. P. et al.,1996, JAMA, 276, pg 898.

MIT Report *continued from page 1*

Response to the MIT report was overwhelming. Many women hailed it as an overdue description of the situation in their universities. Similar studies were spawned at other institutions around the country. As the turn of the millennium approached, people took stock: had the anti-discrimination laws of the 1970s translated to progress in the subsequent two decades, or was equality of opportunity still an unrealized goal?

Then came the follow-up meeting at MIT, attended by university presidents, chancellors, provosts, and 25 women faculty, representing nine top research universities. They met January 29, 2001 to discuss equitable treatment of women faculty in science and engineering. The statement issued by the leaders of the nine universities recognized that barriers to women still exist and promised to work for full and equal participation by women faculty in their institutions.

Backlash

The initial positive news stories and the euphoria of women summit participants and the wider female audience were quickly modified by a new, negative theme in the press. A commentary in the National Review on February 5, 2001, suggested that the nine academic leaders had been misled or were somehow predisposed to write "the latest concession to feminism's Underrepresentation Industry."

The claims in this and several other counter-MIT articles are themselves disputed, by those associated with the MIT report and others. Here we summarize the criticisms of the MIT report and present arguments that those criticisms are weak and ultimately not credible.

The author of the National Review commentary, Dr. Patricia Hausman, is a behavioral scientist and member of the National Advisory Board of the Independent Women's Forum (IWF), a conservative women's think tank. With James Steiger, a statistician and professor of psychology at the University of British Columbia), Hausman posted a report in November 2000 taking issue with the MIT study. (The report can be found at www.iwf.org.)

Hausman and Steiger criticize the lack of data in the published version of the MIT study and suggest the study's conclusions were not supported by the confidential and unpublished data. They base this claim on an anonymous source quoted in an earlier IWF study by University of Alaska (Fairbanks) psychology professor Judith S. Kleinfeld (December 1999, see www.iwf.org), who reported: "a confidential source at MIT,

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Communiqué from the Nine University Summit

Issued by:

President David Baltimore of the California Institute of Technology

President Charles Vest of MIT

President Lee Bollinger of the University of Michigan

President Harold Shapiro of Princeton University

President John Hennessy of Stanford University

President Richard Levin of Yale University

Chancellor Robert Berdahl of the University of California at Berkeley

Provost Harvey Fineberg of Harvard University (representing President Neil Rudenstine)

Provost Robert Barchi of the University of Pennsylvania (representing President Judith Rodin)

Statement:

Institutions of higher education have an obligation, both for themselves and for the nation, to fully develop and utilize all the creative talent available. We recognize that barriers still exist to the full participation of women in science and engineering. To address this issue, we have agreed to work within our institutions toward:

1. A faculty whose diversity reflects that of the students we educate. This goal will be pursued in part by monitoring data and sharing results annually.
2. Equity for, and full participation by, women faculty. This goal will be pursued in part by periodic analysis of data concerning compensation and the distribution of resources to faculty. Senior women faculty should be significantly involved in this analysis.
3. A profession, and institutions, in which individuals with family responsibilities are not disadvantaged.

We recognize that this challenge will require significant review of, and potentially significant change in, the procedures within each university, and the scientific and engineering establishment as a whole.

We will reconvene to share the specific initiatives we have undertaken to achieve these objectives.

MIT Report *continued from page 5*

quite close to the [MIT study] committee ... says that the committee found no gender discrimination." No further details are given in either report.

Kleinfeld had also criticized the MIT study for not making the data public and because some of the women complainants were members of the study committee, thus bringing its objectivity into question. She further argued that the women scientists cited in the report were not exceptionally talented and may have deserved their relatively small fraction of university support.

Hausman and Steiger take the latter claim further, analyzing publication and citation rates for selected male and female scientists in the MIT department of biology, and tallying federal grant dollars received by these scientists over the previous decade. They conclude that the male biologists published papers and were cited at a "dramatically" higher rate than the women. Concerning research grants, they found that although both men and women brought in large amounts of grant money, more flowed to the men, suggesting it is "possible that some scientists have more resources not because of their sex, but because they need them to honor the terms of their research grants."

A Critical Review of the Criticism

The work of Kleinfeld, Hausman, and Steiger received a lot of attention from the mainstream press, including the Chronicle of Higher Education (February 16, 2001) and the Boston Globe (February 7 and 14, 2001). (See also AASWOMEN for 2/9/01, at www.aas.org/~cswa/pubs.html.)

How valid is the IWF analysis? Readers are urged to read the reports for themselves, to assess directly the validity of the conclusions drawn. But for an astronomer familiar with statistics and with potentially biased data sets, the criticism seems astonishingly thin and unsupported.

First, the reason for the confidentiality of the MIT data is obvious: it is a rare faculty member who wants their salary, or grant support, or other sensitive information to be widely disseminated. Given the tiny numbers of women involved in the MIT study — 15 women in the School of Science, compared to 197 men — any information made public would easily be identified with the individual woman to whom it pertained, thus the decision to keep the raw data confidential. The MIT study was never intended to generate a public document, only an internal report to MIT Dean of Science Robert J. Birgeneau. Thus we must rely on the MIT committee, and their credibility, in forming their conclusions.

Well then, should the women who brought this issue to the attention of the MIT administration have been included on the committee? Arguably they had a vested interest in the outcome, and most have benefited from the university's actions following the report's completion. But it is equally arguable that the department chairs and dean had a contrary vested interest, to justify the status quo and to absolve themselves and the university of any responsibility. Excluding the women would have "stacked" the committee in a sense opposite to that created, according to the IWF reports, by their inclusion.

Two options thus would seem viable: (1) to include all the "players" on the committee, and have them come to consensus despite potential biases and opposing agendas, or (2) to create a committee of neutral outsiders. The latter option has some curb appeal but is ultimately unrealistic; aside from the likelihood that no one is truly neutral on this topic, outsiders would require a much larger effort to assemble the equivalent body of knowledge, which in any case would come from the same sources. By instead appointing the women, with their essential knowledge of history and practice at MIT, and by adding men, MIT made as sincere and objective an effort to investigate itself as could be imagined.

In conjunction with the committee, Dean Birgeneau reviewed the confidential primary data, and concluded MIT had distributed resources, including salary, unfairly. Upon seeing the data, reported the Boston Globe, "he made quick remediation," raising the average salary for women by 20%. It is unlikely that such an experienced scientist and administrator could be misled by fairly straightforward data, or that he would take such dramatic steps unless they were well justified.

Furthermore, the decision to undertake a study was initially opposed at MIT by some (white, male) administrators who were not convinced that women had been discriminated against. These were not people easily duped either, but people who can be persuaded by data (they are scientists, after all). And indeed they were persuaded, and ultimately they signed on to the report. After all, lab space and salary are cold hard facts which can be evaluated unambiguously. For example, that MIT had required women to raise a larger fraction of their salary than men, or that men had on average twice the lab space as women, is not in dispute.

Well, were the men better scientists than the women, and thus deserving of MIT's greater support? The Hausman-Steiger statistical study claims yes. They defined "two natural groups" within the MIT biology department: "Group 1"

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corresponding to Ph.D.s earned in the period 1971-1976 (6 men, 5 women), "Group 2" to Ph.D.s from 1988-1993 (7 men, 6 women). (There was no discussion of how the choice of this particular department, or these particular individuals within it, affected the results.) These two small groups spanned different sub-fields of biology, making an aggregate analysis of dubious value. By analogy to astronomy, how meaningful would it be to compare publication and citation rates of, say, cosmologists with stellar astronomers, or theorists with instrument builders?

Furthermore, counting publications and citations is at best an imperfect measure of scientific productivity or excellence, as most scientists recognize. One could instead count numbers of pages published, or numbers of results (though how to quantify?) — what constitutes "one paper," and its content and quality, vary enormously. As for citations, they depend heavily on sub-field, on publishing patterns, on self-referencing, and on who knows whom (particularly in a large field like biology). Finally, I have not myself re-analyzed the Hausman-Steiger data but my guess, from eyeballing the tables, is that the disparities between men and women are not statistically significant because of the small numbers of scientists involved.

Then there is the chicken-and-egg question: were the MIT women scientists given less support because they were less deserving, or did they publish less because MIT gave them fewer resources?

Then there is the chicken-and-egg question: were the MIT women scientists given less support because they were less deserving, or did they publish less because MIT gave them fewer resources? Frankly, the opposing sides will never agree on this point, and there is no definitive proof of either hypothesis. Clearly the MIT administration believed the latter, despite the clear motivation they might have had to uphold the former possibility. The Hausman-Steiger study did not identify the particular women in Groups 1 or 2, but the women biologists at MIT are incredibly impressive. They include: Mary-Lou Pardue, member of the National Academy of Sciences (NAS) and the American Academy of Arts and Sciences (AAA&S); Barbara Meier, member of the NAS; Ruth Lehmann, member of the AAA&S (not eligible for the NAS because she is a foreign citizen); and Nancy Hopkins, member of the Institute of Medicine of the NAS, and the AAA&S, to name just a few. These are brilliant scientists — hardly under-performing women!

Legacy of the MIT Report

The most important impact of the MIT study was that it went beyond sheer demographics of women in science, to report, in at least one environment (MIT), the inferior resources women have been given. That there was a difference at the most senior levels of the MIT faculty, where women scientists have been hired, tenured, and presumably valued for their (immense!) talent, was quite devastating.

This brings us back to the 9-university summit. Was it just a cynical exercise in political correctness? (Odious phrase!) Or were the Presidents of Caltech, Yale, and Stanford as easily duped as that of MIT?

Conservative columnist Cathy Young lamented in her Boston Globe columns that the MIT report was insulting to women because it implied they need special preferences to succeed. An alternative interpretation of the same facts is that it is the men who have historically gotten special preferences and who have as a result succeeded.

Like tenure cases, evaluations of women scientists, and comparisons to their male peers, can be interpreted differently by different people. In the end, evaluation of scientific ability is an inherently subjective process, depending critically on the weight one assigns to various orthogonal attributes. But if the very men at MIT who supposedly allowed the disparity to develop could conclude that this discrimination had happened, it is hard to imagine that three social scientists without access to the primary data, but instead analyzing an arbitrary, limited, aggregate group of scientists from one department, would come to the more correct conclusion.

The legacy of the MIT report is that universities everywhere will be more vigilant, more aware of the possibility of unconscious discrimination against women scientists (and minority scientists as well, one hopes). With good data, from careful internal studies, the U.S. will be able "to fully develop and utilize all the creative talent available," as the nine university leaders recently pledged to do. ❖

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The Charge of The Association for Women in Science (AWIS)

By Catharine Jay Didion and Kelly Meeker

THE ASSOCIATION FOR WOMEN IN SCIENCE (AWIS) is a non-profit, non-governmental organization dedicated to achieving equity and full participation for women in science, mathematics, engineering and technology. As the largest multi-disciplinary science organization for women in the United States, AWIS is recognized as a national leader and innovator due to its success in initiating and implementing key programs for faculty and administration assessment and training throughout government, industry and academia. The Association for Women in Science was founded in 1971 to act as a professional network and advocate for gender equity in the sciences. AWIS goals are pursued on many fronts through our network of 72 local chapters and our national office in Washington DC, which works with the U.S. government, international organizations, and other organizations with complementary goals and missions.

Catharine Jay Didion

Kelly Meeker

AWIS works toward accomplishing its goal of gender equity in the sciences by developing publications regarding mentoring and studies on the climate for women in science and networking. AWIS receives funding from many government and non-governmental offices and organizations, which is augmented by membership dues and donations. AWIS uses its funding to produce publications and complete studies and projects aimed at encouraging girls at a young age to begin studying the sciences, and developing measures and mechanisms to meet the needs of women in the sciences at all levels of education and employment.

Contrary to popular perception, women are still dramatically under-represented in the sciences, throughout industry, government and academia. By 1996, women earned 30 percent of the 1,461 doctoral degrees awarded in chemistry, and 44.5 percent of the 4,365 doctoral degrees awarded in biology (National Research Council Doctorate Records File). Women represent 22 percent of the science and engineering labor force and within science and engineering women are more strongly represented in some fields than in others. More than half of sociologists and psychologists are women compared with only 9 percent of physicists and 8 percent of engineers. Women make up 44 percent of academic faculty overall, but only 24 percent of faculty in science and engineering (Women's Educational Equity Act Equity Resource Center; see Graph 1).

Professional women who are interested in encouraging young women to enter the sciences can best achieve this goal by becoming mentors. Mentoring has been proved an effective mechanism for encouraging girls and young women to pursue their interests not only in the sciences, but also in other academic fields. For the past 10

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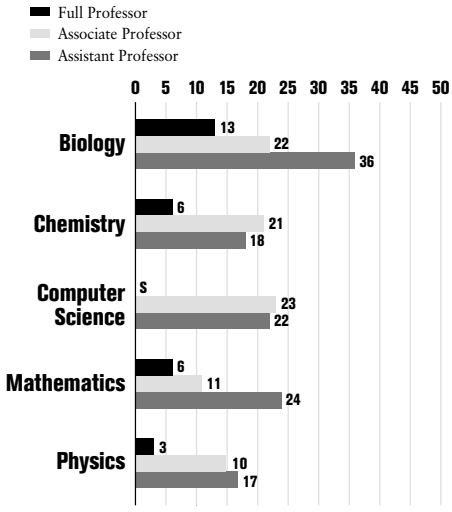
Graph 1

Women as a percentage of science professors, by rank



Source: National Science Foundation SESTAT; American Chemical Society; American Institute of Physics Data for Biology, Computer Science, and Mathematics are 1997; Chemestry is for top chemistry universities in 2000; Physics is 1998.

S=Supressed due to too few cases.

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years, AWIS has established and improved community-mentoring programs for pre-college, undergraduate and graduate students. A detailed publication entitled Mentoring Means Future Scientists, which presents and analyzes the results of this mentoring program, was published. In AWIS mentoring projects, girls at the secondary school level participate in activities and projects geared towards increasing their interest in science, engineering and technology careers, heightening their awareness of scientific career opportunities, and improving their self-confidence in these subject areas. Also, women at the undergraduate and graduate level are encouraged to seek out mentors in order to become involved in the network of the scientific community. AWIS is also involved with MentorNet (www.mentornet.net), an organization that pairs college and graduate level students with e-mail mentors in all areas of science and technology in order to provide guidance and advice.

Activities

Statistics suggest that some of the most important issues for women scientists who are already on the faculties of academic institutions are tenure, promotion, and professional advancement. In order to address these concerns, AWIS has completed a Project on Academic Climate, in which site appraisal teams made visits to different universities and colleges in order to interview faculty and students to survey the atmosphere for women in various science departments. Site visit teams asked a number of questions regarding recruitment and hiring practices; policies on dual career couples, shared positions and maternity/paternity leave; tenure and promotion policies and practices; student and faculty mentoring and advising; and the social atmosphere within the department. In reviewing the responses to surveys and interviews, site visit teams prepared reports assessing the current climate in each institution, and making recommendations for specific actions to be taken to improve the climate. The results from all of the different visits were compiled into a study with overall recommendations and best practices according to the experiences of the institutions visited.

AWIS is recognized as a national leader and innovator due to its success in initiating and implementing key programs for faculty and administration assessment and training throughout government, industry and academia.

AWIS is celebrating its 30th Anniversary from February 2001- February 2002. In order to mark this important milestone, AWIS is working with its network of chapters to plan local events throughout the country. We hope to encourage the visibility of AWIS as well as reemphasize the importance of networking in developing gender equity in the sciences. Also, AWIS is planning a Leadership Conference in Washington, D.C. from October 18-20, 2001. The Leadership Conference Committee has chosen two basic themes: (1) Unity, Science, & Policy; and (2) Service & Careers. The focus will be on AWIS members and providing a forum to explore issues relevant to their careers. All AWIS members and chapters will be invited to attend with two representatives from each chapter.

AWIS was also involved in the establishment of the Commission on Women, Minorities, the Disabled in Mathematics, Science, Engineering and Technology (CAWMSET) by Congress in 1998 in order to develop recommendations to improve the domestic science, mathematics, engineering and technology (SMET) workforce through establishment of equity. AWIS testified in the Congressional hearings surrounding CAWMSET's development, and AWIS' President-Elect, Jill Sideman, served on the Commission. CAWMSET developed a set of recommendations based on specific actions to be taken by federal and regional governments in order to (1) improve the diversity of the SMET workforce; and (2) meet the rising employment needs of the SMET industry by improving access to SMET education. In February 2001, AWIS held the first meeting to discuss the implementation of the recommendations made by CAWMSET.

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International Activities

In June of 2000, the United Nations convened a special session focused on women's issues entitled "Women 2000: Gender Equality Development and Peace for the Twenty-First Century." At this UN special session, AWIS was proud to have taken the lead in organizing two separate but related events: the "Forum on Women in Science and Technology" and "Let Everyone Play: Symposium on the Digital Divide." An AWIS delegation attended the preceding UN special session, the Fourth World Conference on Women in 1995 in Beijing, China. Participants and delegates in Beijing created a Platform for Action, identifying 12 critical areas of concern specifically relating to women: education and training; health; poverty; violence; armed conflict; human rights; power and decision-making; institutional mechanisms; economy; media; environment; and the girl-child.

At the "Forum on Women in Science and Technology," participants reviewed progress made since Beijing and identified areas for future action. While the Platform for Action did not explicitly include science and technology, this session identified four areas (of the Platform for Action) most relevant to science and technology, which were chosen for review and discussion: (1) Environment; (2) Health; (3) Power and Decision-Making; and (4) Education and Training (See Sidebar). It was AWIS's goal in creating the "Forum on Women in Science and Technology" and "Women Crossing the Digital Divide into the Future" to ensure that science and technology be included in every future agenda to empower women.

Global Alliance

AWIS is a founding partner in the Global Alliance, a collaborative effort of several women's organizations committed to increasing the participation of women in the science, mathematics, engineering and technology (SMET) workforce, as well as developing equity for other groups according to ethnicity, age, discipline, language, and cultures. The Global Alliance's primary objectives are twofold: (1) to establish worldwide collaborations with higher education institutions, corporations and government, and (2) to facilitate the development of long-term, sustainable infrastructures in science and engineering for a diversified workforce.

GASAT

The Gender and Science and Technology (GASAT) 10th International Conference will convene in Copenhagen, Denmark from July 1-6, 2001. GASAT is an international organization committed to developing socially responsible and gender inclusive science and technology. AWIS will give two presentations at the GASAT Conference: the first concerns mentoring women in science, and the second concerns transitioning women between education and careers in the sciences. Furthermore, AWIS is collaborating with the Global Alliance to give other presentations on the international aspects of the gender equity issue. ❖

Linking Science and Technology to the 4th World Conference on Women's Platform for Action: Four Areas of Concern Regarding Women in Science and Technology

1 Environment

- Support women's roles in the preservation of biodiversity;
- Encourage participation of women in practices and decision-making involving sanitation, water use, and land use patterns.

2 Health

- Provide access to modern, safe healthcare for all women and children;
- Support research that improves quality of life for women and girls;
- Promote corrective and preventive strategies for reducing death and disabilities associated with childbirth.

3 Power and Decision-making

- Promote women's access to decision-making positions;
- Influence development choices especially around issues that affect energy, food security, use of natural resources, and education.

4 Education and Training

- Ensure equal access to quality education and training for girls and women that includes basic education in science and technology;
- Build up and maintain support systems to encourage access to higher education in scientific and technical fields for women.

Reference: Linking Science and Technology to Women's Needs, developed for the Global Alliance by the American Association for the Advancement of Science with support from the Department of Energy, Office of Science.

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Kristy Dyer is in her last year of Ph.D. research at North Carolina State University and will be starting an NSF Fellowship in Fall 2001 at National Radio Astronomy Observatory. She is an alumna of Mt. Holyoke. She studies thermal and non-thermal X-ray emission in supernova remnants. This article originated in a talk given to the 2001 Invitational Conference on K-12 Outreach from University Science Departments sponsored by the NCSU Science House and the Burroughs Welcome Fund.

What You Don't Know Can Hurt You: Illogical dimensions to being a woman scientist.

By Kristy Dyer

FOR THE NEXT FEW MINUTES I want to you regard me as an escapee from the hard-science zoo. I'll report on the conditions, hopefully finishing before the zoo-keepers note my absence and come after me with nets. The following is my own experience and it should not be assumed that I speak for all zoo animals.

Kirsty Dyer

Certain people (men and women) are drawn to the hard sciences (by which I mean math, physics, chemistry and engineering). The scientific ideals we picked up as we struggled through our classes were worthy and principled. We are detached, we are skeptical, we offer our results up for peer review, our truths can be replicated.

There is a long and noble history of science — we trace our roots back to Aristotle (the use of logical deduction) and Galileo (experiments under controlled conditions). Newton decreed nature could be described by mathematics (although he had to invent the mathematics to do it). Descartes gave us Cartesian reductionism, which among other things specifies that causes can be unambiguously separated from effects. Bacon laid the ground rules for the scientific method, recording observations in an impartial and totally objective way without prior prejudice.

I want to point out that none of the above actually prohibits women or minorities from succeeding in science. This is a noble and high-minded set of rules for making sense of the universe. This is why I fell in love with science. This is unfortunately not the way science is done.

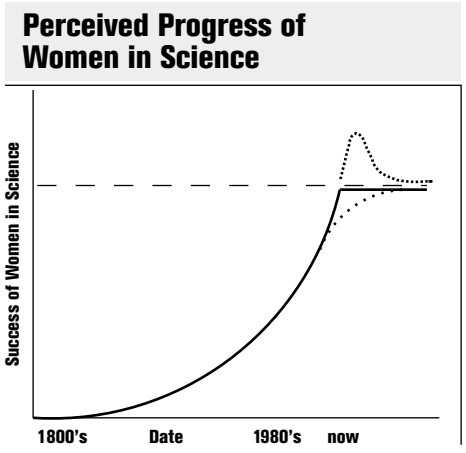
It turns out that science has a culture. Karl Popper, a philosopher of science, found that in fact it is not possible to be totally objective: decisions about what is a relevant observation are influence by background assumptions — in fact, context matters!

"Paradigms Lost" by John Casti gives the following simple example. A series of numbers is given {1, 2, 4, 8} where the "correct" continuation of the series depends on the context: 16, 32, 128 (doubling), or 9, 11, 15 (differences in original sequence), or "Who Do We Appreciate!" which is certainly correct if the context is high school sports.

A second example comes from a former professor of mine. In an effort to bring everyday science examples to a "physics for poets" class, he gave the following test question: "Why are stop signs red?" To which a liberal art student answered, "So they can be easily seen." He felt that this showed up the impossibility of trying to teach non-science majors. (What he wanted was an answer that discussed wavelength and reflected and absorbed light). It seemed to me that the student had answered the question perfectly correctly in a different context.

Thomas Kuhn unearthed further evidence of this unexamined scientific culture. Most scientists have heard of (and some have actually read) "The Structure of Scientific Revolution," which delineates the ways in which scientific progress is made, not according to or within the accepted scientific method, but in a wider scientific culture where scientific paradigms are broken, and then reformed.

Figure 1



In order to understand where these majestic rules break down, I've plotted the perceived "Progress of women in science" (Figure 1). This figure has several interesting characteristics. It begins in the 1800's (ancient history) with zero women in science. It then shows the situation improving as rapidly as possible (sounds like exponential growth to me) with equity either having been obtained in the last decade (independent of whatever decade we are in) or equity about to be obtained (before I reached graduate school at the very latest).

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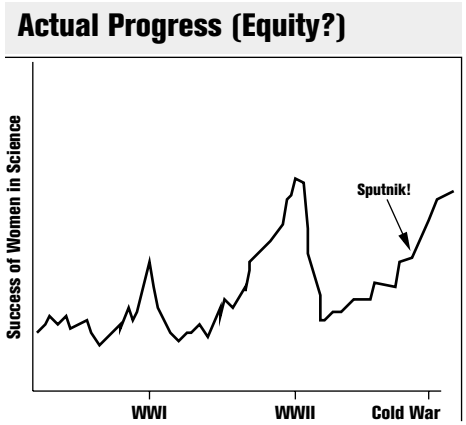
Illogical Dimensions *continued from page 11*

One thing becomes immediately clear — if you think the progress has been an exponential growth curve, clearly an overshoot (indicated by the dotted line) is likely — which explains why so many men in science think we have overshot equity and women are now clearly being preferred for jobs. A second possible curve (the lower dotted line) is the "S" curve beloved of population studies — we are asymptotically approaching equity. If you believe this curve, any complaints about current problems are picking nits, since the problems are so much smaller than in the past and clearly progress is being made as fast as (scientifically) possible.

Unfortunately the real progress of women in science is much more like Figure 2 and there are consequences for mistaking it for Figure 1. To start, the figures disagree over whether inequities have been fixed. Figure 1 also shows monotonic progress, implying that women in science never lose ground once gained. It's a daunting reality, not only that we at times have lost ground, but that the number of women working in science is less affected by education and public policy than by an outbreak of war (Sputnik was mentioned as major motivating factors in the careers of the first three speakers: Marye Ann Fox, Jane Butler Kahle and Jack Rhoton!). I don't know where to put the equity line in Figure 2. If you taught at the university during WWII, and were laid off when the men returned from the front, had you (momentarily) achieved equity?

Figure 2



The perceived graph has no historical women scientists, where as the actual graph shows that there have always been a few women in science. This leads to what I'll call the "Marie Curie Effect." Often we are called upon to list famous scientists:

Einstein
Newton
Feynman
Marie Curie
Stephen Hawking

(Odd isn't it how some scientists have two names and some only one?). We put Marie Curie on the list because we want to include role models for women and we don't want women's contributions to be forgotten. However, from glancing at this list I would deduce that 20% of the great historical achieving scientists were women. We are over-representing women, and therefore minimizing their absence and the issues that lead to that absence. When we make these lists we never mention all the women of Marie Curie's cohort who were unable to become scientists. This also leads to another fallacy — we like to emphasize that our hero-scientists have overcome enormous obstacles to succeed — Einstein being a Jew in Nazi Germany, Newton banished from the University due to the plague, etc. However when we over-represent women in science we suggest the following: *"If women succeeded historically in producing important scientific work despite enormous obstacles (such as not being allowed access to higher education!) then if women today are not succeeding it must be because their work is not of sufficient scientific importance."*

In fact Marie Curie is not statically significant in her time. These obstacles (as well as more subtle ones) were effective in reducing the number of women scientists from N to basically zero. [Ed. Note: c.f. See "Science Has No Gender" by Sethanne Howard, STATUS January 2000.]

Here I am going to take an unpopular stance. I am going to sing the praises of mediocrity. We will not have achieved equity in science until mediocre women achieve tenure — women who have solid but uninteresting research programs, have brought money into the university and are (just) adequate. Most people in favor of the inclusion of women in science argue that women make great scientists. I want to point out that most men in science don't qualify for the list of greats I've listed above. If anything, the scientific record has shown that progress is made on the back of lots of mundane, dull labor, as well as new ideas from unexpected sources.

The scientists who are concerned about women in physics and astronomy talk a lot about the "leaky pipeline" (Table 1). Each part of the pipeline should be flowing into the next, but instead is leaking girls/women. You could set the "necks" at different levels but I've chosen a few common ones. Where I could find data I've placed the ratio of women/men for Physical Sciences + Engineering on the left and the percentage of women/men in Astronomy (my field) to the right. The early stages, marked with "?" are guesses on my part.

The problem with this pipeline concept is that there is, in fact, no "flowing" going on. Rather, it is a "snapshot" of populations at any given

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Illogical Dimensions *continued from page 12*

moment, the easiest data to gather. The girls interested in science are not the same population that becomes tenured faculty — no one has ever done this longitudinal study.

There are consequences for mistaking a "snapshot" pipeline for a longitudinal study. It places the largest responsibility for the leaks at the "soft" end — home life, kindergarten, grade school, high school. These are areas not in the responsibility realm of hard scientists. It lets hiring committees, tenure committees and conference organizing committees off the hook. Effectively they say, "If we were given anything to work with we could include women but until there are women to include, we are just doing our job."

At some level we do recognize this is a "snapshot". Often we think it fully explains the number of tenured women professors — there were simply fewer girls interested in science in the 1960's when they were young. There is however no scientific evidence to support that thesis — I suspect that the 1960's pipeline was narrower at the beginning but also less efficient than the present pipeline at "leaking" women at later stages. I encourage someone to refute this!

We are encouraging girls in science — where do we expect them to go? The problem is complex — the closer a woman comes to being a model scientist, accepting without question the scientific culture I enumerated above, the less prepared she will be to cope with the inequities she will encounter. The culture as it stands simply does not allow the following questions to be posed, let alone answered: *Is peer review biased? Are men and women in science evaluated by different standards? Is there a culture to science that works to exclude women?*

There are probably more questions I should be asking but as a model scientist I can't even formulate them. I do know that when I talk to girls interested in science, undergraduates and potential graduate students, I have to admit I lie to them — I tell them how wonderful science is and I point to the one or two (statistically insignificant) women at the top to prove it can be done. I don't tell them how many women drop out of graduate school or how dismal the employment statistics are for women who do graduate.

There are many desires and plans to include women and minorities in the sciences — these admirable solutions don't exist in a vacuum — it's worth examining the paradigms they assume as context. There are several standard paradigms:

- The deficit model. Girls are like boys but they lack certain things. Programs that try to give girls hands-on experience in labs, because they often get less experience than boys are operating within a deficit model.
- The difference model. Sarah Berenson's Girl Math program operates within a difference model. She believes that girls are different than boys, no less talented, and that by changing the context of math problems we can involve girls in math relevant to their values.

I believe we need to move to a climate model if we are going to understand and address these problems. Both the deficit model and the difference model take as a standard the way boys/male scientists do things. Both put girls/women scientists under the microscope to examine why they are different. This is like finding a three-legged frog in a polluted pond and taking the frog back to the lab for an interview, demanding "Why did you grow an extra leg?" without ever examining the pond, the environment.

There have been quite a few studies of women in science — I think it is time to study men in science — the default culture, and to make that culture the responsibility of the scientists. Women, who make up less than 5% of tenured physics faculty, are not in a position of power. It is a fact that we are not the ones granting tenure, directing research funds or guiding hiring committees — we cannot solve the problem of the lack of women in science by studying women

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Table 1

Percentage of Females in the Physical Sciences and Astronomy

Percentage of Females who...

	Physical Sciences	Astronomy
Are interested in Science (Pre-Junior High)	~50%?	~50%?
Are interested in Science (Post-Junior High)	~30%?	~30%?
Take High School Calculus	>20?%	>20%?
Graduate with a Science Undergraduate Major	47%	33% (physics)
Are in a Science Degree Graduate Program	45%	25%
Graduate with a Science Ph.D.	30-35%	20%
Are Tenure-track/Research Faculty	38%	18%
Are Tenured Faculty	11%	5%

*

This "Letter to the Faculty" was submitted to an astronomy/astrophysics department at a major East Coast university by graduate students from that department. It is reprinted with permission of the students provided we do not identify the university.

Anonymous Letter to the Department Faculty

March 16, 2000

To the Faculty:

THE PURPOSE OF THIS LETTER IS TO HIGHLIGHT SEVERAL CONCERNS, held by some of the graduate students, regarding the status and future of women in the department. Our comments are divided into two main categories: 1) the lack of women on faculty search short lists (which leads to a lack of women in faculty positions), and 2) the high attrition rate among female graduate students.

Having observed eight faculty hires over the last seven years, we, the undersigned graduate students, have noticed what appears to be a bias in the make-up of the short list candidates. With the exception of the hire where the university mandated that the department must hire a woman, there has never been more than one woman on the short list. Three of the short lists have not had any women on them at all.

We want the best candidates to be hired to our department, and we do not mean to imply that there has been an intentional bias in the hiring practices. However, it is hard to believe that over so many hires that there were so few qualified women who could have been considered. It is equally difficult to believe that only one of those women was qualified enough to receive a job offer.

To observe that women do not get considered for faculty positions is demoralizing, and we believe it contributes to the difficulty this department has in retaining women graduate students. Female students in our department are choosing to leave research at a much higher rate than the male students. Of the classes entering between 1989 and 1998, 59% of the women and only 28% of the men have left the program so far without a Ph.D. These numbers are especially worrisome when we consider that very few women are admitted and accept graduate positions here in the first place. There are no easy answers to why so many more women than men leave the program before earning a Ph.D., but we believe a more supportive and positive environment could help.

We would like to suggest that, if in the future the committee feels that none of the women who have applied should be on the short list, that an effort be made to see if anyone [else] should be invited. Two possible ways of doing this are:

1. Check the CSWA database at http://www.stsci.edu/stsci/service/cswa/women/. This is a searchable database where women are listed by their fields of expertise. This database only contains women who have submitted their information to the list, but it provides a good place to start.
2. Check recent AAS abstracts within the fields being considered for the job for women working within the field, but who have not applied already.

Greater equity in hiring will not completely solve the problem of the atmosphere in the department for the students, but it will help.

Another way in which the department could be more supportive of its female graduate students is to make it clearer that the department supports the university's channels for dealing with sexual harassment. Ways to do this would be to give stronger encouragement to attend the sexual harassment training, and to make sure all students, not just teaching assistants, know what the university procedures and policies are. While there have been no overt cases of sexual harassment in the collective memory of the current graduate students, there have been several minor incidents. Therefore, it is important for the department to make a clear statement that sexual harassment is not and will not be tolerated.

The transition from undergraduate to graduate student can be challenging. Students must learn to work more independently and learn how to balance classes, teaching and research. This can be an overwhelming experience for both the male and female students. We feel having a mentoring program where each of the incoming students is paired with a senior student could ease this transition and help prevent losing the students who leave out of frustration with the system. The senior graduate students can relate to the problems of a first year student in a way the faculty advisor can not, simply because the graduate student is so much closer to the experience.

We wish to emphasize that we recognize and appreciate the individual efforts regularly made by many of the faculty to encourage female graduate students. Such efforts send a strong

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Ann Wehrle is a staff scientist at the Interferometry Science Center (JPL and Caltech) where she does strategic planning for science for the Space Interferometry Mission. She leads the SIM Key Project "Binary Black Holes, Accretion Disks, and Relativistic Jets: Photocenters of Nearby Active Galactic Nuclei and Quasars". She and her husband have an 8-year old daughter and a 4-year old son.

Women and the Work/Family Dilemma by Deborah J. Swiss and Judith P. Walker

Book Review By Ann Wehrle

Women and the Work/Family Dilemma, by Deborah J. Swiss and Judith P. Walker, (Wiley: New York, 1993) is out of print, but available through www.bookfinder.com.

THIS IS THE BEST BOOK I have read about professional women and the trade-offs made in combining work and family. The authors surveyed 902 graduates of the Harvard Medical, Law, and Business Schools, aged 33-45 years. Seventy-five percent of the women were married, 66% were mothers although 25% volunteered that they had had fertility problems. Thirty percent had been self-employed at some point in their careers.

In sharp contradiction to the authors' expectation of finding many examples of workplace support for these "top-credential" women combining careers and family, they discovered most women had no recognition in the workplace for their dual role. They variously chose to "fast track" in early years, to consciously start out in "family-friendly" companies, to work part-time, to go into business for themselves, or to stay home full time after their children were born. Many moved among these options, though women who left the "fast track" never returned. Many moved to the "mommy track" in their careers, with lower pay, fewer promotions, and less professional recognition.

When do women change their plans or rebalance their lives? Often, there is a triggering event such as a child's serious illness or a difficult pregnancy. Simply announcing a pregnancy may be followed by serious repercussions on the job, for example, losing clients, patients, or the most "interesting cases," or even having the offer of a promotion withdrawn. Women, exhausted after years of doing the job at home and at work — one woman described being so tired that her eyes would not focus at the end of the day — may find a last-minute business trip or missed soccer game becomes the "straw that broke the camel's back."

Women were also painfully aware that the first woman to take maternity leave in her company sets the standard by which other women are measured; if the first woman took two weeks' maternity leave, the next woman was expected to do the same. Women compartmentalized personal and professional lives, and set firm limits on the encroachment by work onto "family time". Some women went as far as to recommend others "have their children at one job, and have their career at their next job"— in other words, hide their family responsibilities at the second job.

In the event you can't get the book, here are some career and family strategies that women in astronomy may find useful:

- Avoid long commutes.
- Hire nannies; live-in nannies make it much easier to travel.
- Pay for house cleaners and handymen.
- Carefully manage home responsibilities by negotiating with husbands.
- Make decisions quickly and efficiently, e.g., handling paperwork only once or pre-arranging backup child care.
- Make yourself highly valued at work before having kids.
- Work part-time, especially when nursing babies.
- Call upon women friends for assistance.
- "Vote with your feet" if companies will not accommodate family life. ❖

Anonymous Letter *continued from page 14*

message to current (and prospective) female students that our department is committed to equality in the workplace. We hope that the suggestions presented in this letter will help to further those efforts and to improve the atmosphere in the department in general.

Signed,
(Names Withheld) ❖

Ed. Note: This letter was signed by 9 women and 3 men. In the time since this letter was presented to the faculty, work has begun on trying to implement the proposed mentoring program, a female was on the short list for a recent faculty hiring and there has been an increase in the number of females admitted to the graduate program (nearing 50%).

In the interest of men?!

Joanne M. Attridge (MIT Haystack Observatory) who was in attendance at the January 2000 AAS meeting in Atlanta snapped this amusing photo. Extra issues of "Astronomy Magazine" and "Sky & Telescope" are available for sale at this newsstand, ironically in a section called "Men's Interest". The magazine stand was in the mall adjacent to the conference hotel.

AAS Meeting Pasadena Session 29

Committee on the Status of Women in Astronomy

Special Session Oral
Monday, 2:00-3:30pm, C211

29.01

Isn't a Millennium of Affirmative Action for White Men Sufficient??

Debra Rolison (NRL)

Abstract:

Science and engineering departments need more women as faculty-and not only to show their undergraduate students (the majority of whom are now women in many disciplines) that a career in academia is a viable path. In my field, statistics show that one-third of U.S. Ph.D.s in chemistry are awarded to women, yet according to cocktail folklore, applications from women for advertised positions are only 10% (or less!) of the total. Why aren't women applying to academia in proportion to their numbers? Why are they voting with their feet against a career in an institution they know all too well? The disproportionate absence of women from the applicant pool warns that an unhealthy environment exists in U.S. academic departments: unhealthy to those professors who want to play a continuing, rather than merely genetic role in the lives of their children and unhealthy to those women, who once they demonstrate productivity, scholarship, and mentorship, still reap less respect (and the ancillary rewards of space, salary, funding, and awards) than their male colleagues.

Should Federal funds be withheld from those universities that do not increase their departmental faculty hires to reflect the pool of U.S.-granted Ph.D.s? Can the threat of the loss of Federal dollars be the impetus for the changes necessary in American universities in order to create a departmental environment that women are willing to call home? Many posit that such changes will concomitantly improve the academic experience for women *and* men, faculty *and* students. If the "system" is broken, and many of its citizens think it is, can it be fixed? Plausible action items up for discussion include such practical, achievable alternatives as aggressively recruiting good women candidates for faculty openings, fairer evaluation of the contributions and productivity of candidates and faculty who are women, ensuring on-campus day care, mentoring the junior faculty through the minefields, and really rewarding the good teachers and advisors because of how they guide and challenge their students. It is not coincidental that these suggestions help men, too.

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Diane Hoffman-Kim is Assistant Professor in the Department of Surgery and the Department of Molecular Pharmacology, Physiology, and Biotechnology at Brown University. She received her B.S. in Optics Engineering from the University of Rochester in 1988, her Ph.D. in Medical Sciences from Brown University in 1993, and held postdoctoral positions at MIT, Harvard, and The Bunting Institute before joining the Brown faculty in 1998. Her research spans the fields of biomedical engineering, cellular and developmental biology, cardiology, neuroscience, and tissue engineering. She is currently director of the Collis Cardiac Surgical Research Laboratory.

Why Women Leave Science

By Diane Hoffman-Kim

IN THE COURSE OF MY CAREER in engineering, applied medical science, and cell biology, I have come to see myself not merely as a scientist but as a woman in science. As a result, I have come to value collaboration and openness to different perspectives and fields — in short, dialogue and community — that can better promote scientific inquiry. While the numbers and prestige of women in science are rising, we are still immersed in methodological paradigms of scientific research that were developed in eras when most scientists were in fact white, middle or upper class men. As a woman in science, I have lamented the isolating scientific culture that valorizes individualistic, competitive, and specialized approaches."

The previous paragraph was from a personal statement for a postdoctoral fellowship application I wrote in 1997. Three years later, as a junior faculty member, I find that it still sums up much of my thinking about the relationships between scientific culture, the process of doing science, and women's success.

I was asked to consider why women leave academic science. I took an informal survey of my female teachers, colleagues, and students in science, and received responses from a group diverse in race, culture, sexual orientation, and age. Themes that emerged include: overt discrimination manifested in lower salary, less prestigious projects, etc.; sexual harassment; assumptions about women's lack of scientific abilities from early education onward; lack of female role models; and difficulties finding livable means of reconciling the demands of work and family; just to name a few. These issues still strongly influence women's lives, and women scientist's lives in particular. I ask you to consider how much more productive these women would be if we did not have to expend vast amounts of energy considering these work-related issues, rather than considering the actual work!

What I'd like to focus on is what I find problematic on a different level: the more subtle, more deeply internalized views of women, and of science, that make the two seem mutually exclusive and incompatible. Sue Rosser and others have stated that younger women are often not taken seriously in their work environment, and many women are excluded from important informal information exchange that goes on in the laboratory. This resonates directly with my experience and with that of my female colleagues. Often styles of discourse that were created, maintained, and dominated by men, ultimately function to exclude women, to impede their confidence, communication, and access to information essential for their careers.

For example, many women have told me they are interrupted and drowned out during laboratory group meetings, the primary settings for communication, learning, information gathering, and self-presentation within a research group. These anecdotes are strongly supported by studies of group meetings, that demonstrate that women are interrupted by men and have their contributions ignored or misattributed more often than are other men. Many women interviewed described discomfort with male-dominated combative communication styles. And if discomfort were not bad enough, the fact remains that if these women wait to speak, they lose opportunities for dialogue that are essential for their learning. Sheila Widnall stated this distinctly in her address as president of the AAAS: "[Students who avoid] such professional experiences as opportunities to present and defend research results in regular and productive group meetings, to evaluate and criticize the work of peers, to formulate and carry out research tasks of increasing importance, to participate in dialogues and debates about scientific and technical issues, and to discuss further career plans as they relate to current interests and activities ... because of a lack of self-confidence or because they find them painful, are deprived of an important component of the graduate experience ... and they are unlikely to be recommended by their mentors for important opportunities in their profession." I would add that in addition, such women are perceived as not having that vaguely asserted but all-important quality — "what it takes" to succeed in science.

Many women are also put off by a reverence for exclusive individualism and a scorn for

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Why Women Leave *continued from page 17*

collaboration in the process of doing science. It is not the case that these women do not want to work independently; however, they find it offensive to be told by a fellow male student, "I spent many hours figuring that technique out; I'm not going to show it to you just because our advisor said you should ask me. Learn it yourself." Nor do women appreciate having their requests for technical advice from a colleague referred to as "getting too much free help around here." When an advisor gives two students the same project without telling each of the other's assignment, or when a supervisor takes a brainstorming session about why an experiment has generated unexpected results, and turns it into a competition to see who can "make the project work," many intelligent, highly capable women wonder where the spirit of inquiry has gone, and indeed, wonder whether they have the right personality for this work. They feel that they do not belong to this club of scientists whose accepted practices are largely unarticulated, difficult to learn, and often clash with many aspects of themselves that they bring to this pursuit.

Research has shown that as women experience the world of professional science, they find that science still runs as a 'boys only' enterprise. This is not surprising, since Western culture socializes boys, and not girls, to develop characteristics typically assumed to be masculine: independence, emotional toughness, objectivity, and pure rational thinking — the characteristics most valued by scientists. Consequently, becoming assimilated into the prevailing culture of science is an integrative process for men, in which they have to adapt in some ways, but they face no challenge to their identity as men in our society. For many women, however, the experience of entering and assimilating into the scientific culture challenges their core sense of self.

Some women work through the laboratory culture and training environment and thrive, creating and maintaining a strong sense of self. However, many of these clearly successful women articulate similar problems with the established paradigms of doing science. A colleague of mine, who is one of three women in a male-dominated lab group, told me that her male co-workers complain to her "You're fine, you're confident and great to work with. It's those other two that are a pain; they're timid, underconfident, we have to be sure they get to speak, and we have to coddle them." In response, she has said, "If you want to have a 'me' for a colleague, you had better figure out how to help them develop. They are me, as I was five years ago!"

I do not believe that coddling women and eliminating all competition from science are useful ways to address these issues. I would like us to continue to find ways to help women develop their strengths as people and specifically as scientists. Leslie Barber, among myriad researchers, raises the question that women in science desperately want answered: "Is equity for women in science and engineering, then, an impossible goal? If the culture of science is assumed to be immutable, it may be. However, there is little reason to believe that existing cultural norms are necessary to the pursuit of excellence in science and engineering. More likely, they provide a comfortable, supportive, and familiar environment for those who have traditionally been scientists, that is, men." To this end of changing the culture of science, I will come to the point raised many times before — the need for a critical mass of women in science at all levels. I would assert that the current definition of at least 15 percent falls far short of what is actually needed to bring about qualitative changes and improvements in conditions. Etzkowitz and colleagues have explained why this is so following interviews with 30 academic science departments. "The fallacy of critical mass as a unilateral change strategy is that female faculty pursue strikingly different strategies. Despite some progress, organizational structures within departments, and the divisions they engendered, continued to isolate women. Furthermore, the dispersal of women students into male-dominated research groups sustained isolation even when there was a critical mass in a department."

I find that to mentor and to give examples to younger women, working toward full demographic representation of women, is essential for women's success in science. Otherwise, with one established and dominant norm of what a scientist does and is, who in the male-dominated research group will be chosen for a project, nominated for a fellowship, sent to a meeting? In terms of opportunities and careers, the stakes only rise from here. Clearly and historically, the chosen one has been the person who most easily fits the norm and the model. I believe that with full representation, this model can evolve to include the woman scientist among all creative, productive scientists. ❖

Portions of this article were published in "Women in Science and Engineering - Choices for Success" Ed. C. C. Selby, The Annals of the New York Academy of Sciences Vol. 869, 1999. It has been reprinted here with permission from the author.

Illogical Dimensions *continued from page 13*

in science because women in science don't actually have control over the problem.

I think until we do this — examine the underlying culture of the hard sciences we will not be able to place effective patches on the leaky pipeline. I worry that it's dishonest of us to work so hard to patch the beginning, when even students who clear many hurdles, will simply be cannon fodder in graduate school. And I think we need to teach the culture of science to students at all levels — knowing the unspoken culture as well as that noble facade can provide them with the tools they will need to overcome barriers, barriers the statistics make all too clear. ❖

Further material on the culture of science and its effect on women:

"Women Science and Technology: A Reader in Feminist Studies" by Wyer et al. 2001, published by Routledge.

Statistics on women in science and engineering came from the NSF: http://www.nsf.gov/sbe/srs/nsf00327/pdfstart.htm (2000).

Statistics on women in astronomy came from STATUS June 2000 http://www.aas.org/~cswa/, and from a 1999 AAS survey which was reported in Bulletin of the American Astronomical Society 31, 1552 #121.01.

"...when I talk to girls interested in science, undergraduates and potential graduate students, I have to admit I lie to them – I tell them how wonderful science is and I point to the one or two (statistically insignificant) women at the top to prove it can be done. I don't tell them how many women drop out of graduate school or how dismal the employment statistics are for women who do graduate."

Illustration by Ann Feild

"You know, she tries, but he's just so much FASTER than she is!"

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