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RECRUITING WOMEN FACULTY: TWO PERSPECTIVES

Recruiting Women Faculty: A Department Chair's Perspective

Richard Wolfson

Recent issues of this *Gazette* have featured graphical displays of encouraging statistics on the proportion of women in the American Physical Society. Data from the 1990 APS membership survey, in the February 1991 CSWP *Gazette*, show that while women comprise 6.4 percent of the total APS membership (APS 1990 membership survey), the proportion of women among members under age 30 jumps to 14 percent. Further analysis, reported in the April *Gazette*, shows that the ratio of women to men among APS members climbs from 1 in 40 for members over 45 years of age to 1 in 7 for those under 35. Indeed, fully 60 percent of the women in the APS are under the age of 30. Assuming that young women continue to choose physics in these numbers and that they remain with the profession, the statistics portend impressive gains in the number of women physicists.

The editor for this issue is Richard Wolfson; assistant editor is Amy Halsted.

In This Issue:

How are these changes affecting college and university faculties, whose members play a crucial role in encouraging young women and men toward careers in physics? Unfortunately, the percentage of women faculty members does not yet reflect gains in the proportion of women in the APS as a whole; today, women comprise only 4.5 percent of college and university physics faculty, and for universities alone an even lower 2.9 percent of full-time faculty in the professorial ranks are women (see Fig. 1 for a more detailed breakdown). Even at the assistant professor rank, where female representation would be expected to increase along with the numbers of young women in the APS, women comprise only 6.6 percent of the faculty. These low figures mean that roughly half the physics departments in the United States have *no* women faculty members.

The challenge to physics departments in recruiting and retaining women faculty begins with the application process. This year's experience at Middlebury College is not atypical, as we sought to fill a tenure-track position at the assistant professor level—a position being vacated by the resignation of the only woman in our department. Positions at colleges like Middlebury are highly prized by physicists whose career goals include undergraduate teaching as well as research, since we offer reasonable teaching loads, top-quality students, and a real commitment to faculty research. This year's applicant pool numbered 269, of whom 21 were women. The proportion of women among our applicants—7.8 percent—is only about half the proportion of women among APS members in the under-35 age range most likely to apply for an assistant professorship. Interestingly, the women also differed substantially from men in the ratio of foreign to American applicants. Whereas well over half of the men applying to Middlebury were Americans, a substantial majority (62 percent) of the women were of foreign origin (see Fig. 2). This difference is consistent with the fact that a higher proportion of women than men among U.S. graduate students in physics are foreigners. (The opposite is true in most other graduate fields, where roughly 50 percent of the men are foreigners, but only 25 percent of the women.) The increase in the proportion of foreign women in recent years also explains much of the increase in the overall numbers of women in physics.

Our criteria for candidate selection at Middlebury always include a clear indication of potential for excellence in these women had been overtly harrassed because they were female science faculty, but by a group that I had never anticipated would cause these kinds of problems: They were harrassed by sexist students! Others, while not overtly harrassed, nevertheless found themselves victims of students' gender biases. I had anticipated that women science faculty might face problems from people with outdated points of view, but I had supposed these people might be older members of the faculty or administration. Instead, several women scientists told me of students who demand a "male" teaching style or who complain that the professor is "too short" or her voice "too high." Many of the women I met felt that it was much harder for a woman teaching science to win the respect of the students. To some of the women faculty members, students showed a clear lack of confidence in their subject knowledge, despite academic credentials that were every bit as sound as their male counterparts'. I found these revelations very discouraging, not only in anticipation of the difficulties facing a new female professor, but also because of the implications about the slow rate of change of attitudes toward gender in our society.

On the positive side, most of the departments I interviewed with seemed like they would be very supportive environments to work in. Many faculty members seemed quite sensitive to the special needs and problems of a new, young faculty member struggling to achieve teaching excellence while setting up a research lab, and who also happens to be the only woman in the department. All the physics departments at which I interviewed were small, with five to eight tenure-track positions. In several of the departments, had I taken the position, I would have been the youngest member of the department by about 20 years. However, faculty members I talked with were sensitive about the possible feelings of isolation that could arise in such a situation. At the opposite end of the departmental age structures were departments in which I would have joined one or more relatively new colleagues in the inevitable competition for tenure.

Finally, many of the chairs of the physics departments as well as members of the colleges' administrations were more understanding than I expected them to be about the extra challenges facing women who wish to pursue a professional career in academia, especially while raising a family. Since this is the overwhelming issue for me personally as a woman scientist, I felt encouraged by the wide range of possibilities and solutions I encountered for balancing family and professional life. Most administrators seemed willing to negotiate on maternity leave issues and on adjusting the tenure clock for maternity and other family-related leave. In some cases, special arrangements had been made for couples to share positions, or for faculty to work part time for an extended period. Several of the colleges had campus day care facilities. I have, of course, heard of many instances where such attitudes were not prevalent and where women seeking professional flexibility in order to raise a family faced active opposition from their departments and institutional administrations. The colleges where I interviewed seemed to offer a welcome contrast.

My interviewing experience has shown me that a faculty position at one of the leading undergraduate colleges could make for a rewarding professional career, and that sensitivity to the special concerns of women scientists is in many respects higher than in some universities and in other institutions that employ physicists. At the same time, most of the women scientists I met had remarkably similar stories of the difficult problems they faced getting established as teachers and researchers, and of the surprisingly widespread gender bias on the part of students. My five college interviews led to two offers of tenure-track faculty positions, both of which I considered very seriously. But I was also offered two post-doctoral positions. In the end, I decided that the best option for me right now was a post-doctoral appointment, so I declined the faculty positions. I still hope to teach at a liberal arts college after I finish my post-doctoral work.

Ruth Ellen Thomson, a graduate of Carleton College, is completing her Ph.D. in physics at the University of California at Berkeley. An experimentalist specializing in scanning tunneling microscopy, her professional goals include teaching undergraduate physics.

CSWP-SPONSORED PANEL DISCUSSION AT MARCH MEETING: ISSUES IN EARLY CAREER DEVELOPMENT

At the March APS meeting in Cincinnati, approximately 160 men and women attended a panel discussion hosted by CSWP chair Millie Dresselhaus, focusing on issues in early career development for women physicists. The three panelists, their institutions and topics were Laurie McNeil, University of North Carolina, "Things They Forgot to Tell You"; Cherry Murray, AT&T Bell Laboratories, "How to Survive and Prosper in Industrial Research in Physics"; and Barbara Wilson, Jet Propulsion Laboratory, "Visible Career Paths in Government Laboratories."

Dresselhaus introduced the topic by discussing the under-representation of women in physics generally, and in comparison with women in other sciences. She also pointed out the preponderance of young women in the small population of women physicists in the U.S. [See graph on page 12 of *CSWP Gazette*, Vol. 11, Issue 2, April 1991].

Laurie McNeil began by observing that the large majority of physics faculty members are older men, who may be unnerved by the presence of a faculty member who is the same age as their daughters. "We make them very nervous, and nervous people engage in some very strange behavior," McNeil said. "In general your colleagues want to do the right thing but simply haven't figured out what it is." McNeil went on to say that any truly negative feelings that a new faculty member perceives may be related to battles about hiring priorities fought before she arrived, and which may break out again at tenure time. Unspoken criteria for research or for tenure can make department politics confusing to someone of a different gender and generation, she observed. If possible, she said, find out from a recently tenured person what you need to accomplish in order to succeed.

McNeil stressed the importance of learning to write proposals from others who do it well. Learn what a referee looks for, she said, and don't neglect the nonscientific aspects such as budgeting. Mentors are also very important, and women should not hesitate to look beyond the department or the subfield to find these individuals. "Simply being wonderful is not enough," she cautioned. Networking and "buttonholing" people at APS meetings are part of becoming known and making others aware of your work.

Cherry Murray began in a similar vein by pointing out that superb technical work is essential to success, but it is not the only ingredient. There is no such thing as tenure in industry, she said, but the publish or perish axiom does apply. Murray suggested several rules to follow in an industry career. Keep an up-to-date resume and a list of long range goals, both of which should be reviewed frequently to assess progress, identify obstacles and keep objectives in sight. "You have to get funding for research, but no one tells you how," she said, so find a nurturing mentor. Set priorities and hone time management skills, which boils down to knowing how and when to say no. If you combine career and family, she said, "be prepared not to sleep for several years." Learn to manage stress, because as she said, "you are never going to be perfect."

Murray's last two pointers have to do with presenting oneself to others in the physics community. She emphasized the importance of developing technical writing and speaking skills. "Every talk you give is a job interview, and first impressions shape your career," she stated. She advised women to become involved in the physics community within and outside of industry, and in professional organizations. It is important to become recognized as a contributor, attend and organize seminars, ask questions, and not to be afraid to use increased visibility as an advantage.

Barbara Wilson observed that the first step in a physics career is deciding clearly what one wants, and then learning the system and using it to achieve those goals. Using the system in a government laboratory is an extra challenge because some procedures or methods are in place due to legal requirements, some are laboratory traditions and still others are simple inertia or habit. Making these distinctions is crucial, especially before taking initiative. Protocol and hierarchy are more important in government than in industry. Echoing McNeil and Murray, Wilson said the assistance of a mentor is invaluable in learning how to get things done.

"Every talk you give is a job interview, and first impressions shape your career . . ."

—Cherry Murray

Wilson suggested strategies for advancement within a government lab. "Figure out what needs to be done and do it without waiting for someone to tell you," she said. Take initiative and bring solutions, as well as questions, to your boss. Learn your boss's job, and make sure that subordinates learn yours. Let the key people know what you've accomplished by sending them memos or through less formal communication. Take responsibility but learn also to delegate, Wilson advised, and don't get bogged down in doing the best job on every single task. Wilson advised against "cold calling" with research proposals; learn instead what is being funded and by whom. Tailor and target your proposals accordingly and make sure the agency knows you.

After Dresselhaus, McNeil, Murray and Wilson spoke individually, the floor was opened to questions from the audience and the following lively discussion ensued. Responses are paraphrased from notes taken at the session.

Q: Did your success change you in ways you didn't like or expect?

Laurie McNeil: I grew as a person, but I also became more cynical. I'm less naive now.

Cherry Murray: I think I'm still the same person, but when I had my son I learned to be a lot more organized. You have to do it so you do it.

Barbara Wilson: I have more power so I'm freer to speak my mind, and I'm more comfortable with myself.

Millie Dresselhaus: I never expected my life would be so extraordinary. You learn a lot from your family and from having a career.

Q: How do you find the right mentor?

CM: Networking: talk to those at your level, people who were hired about the same time you were. Get to know successful people. They teach, you learn.

BW: Make an active search. Use opportunities to talk to those further up in the system. Remember that most people like to be listened to, and want to help.

LM: Don't restrict your choice to those you see constantly. Make a nuisance of yourself until your chosen mentor decides you are worth nurturing. Also remember to filter the advice you get, it may have a history behind it.

MD: If you are shy, assert yourself. The biggest stumbling block is knowing you need a mentor, admitting that you need help.

An audience member observes: I've been in a government lab for 20 years, and I'd like to pass on my own rules to the rest of the audience. (1) You never spend "brownie points," you only accumulate them, and establish the right to get more of the things you need; (2) Bad behavior is very well rewarded in others, but conversely; (3) The only way to get yourself promoted is to be much better than anyone else.

Q: Some women do slip through the system, and don't end up with successful careers. Where are the thresholds, the difficulties, and how do you get through them?

CM: For me the worst part was graduate school, before generals. I suddenly didn't understand why it was worth going through all this trouble. I went directly to AT&T afterwards.

BW: When I was at Bell Labs, I got into an area that was not of general interest. I chose to stay there, but I eventually made the decision and moved into a more mainstream area. Watch out for getting sidelined, and work hard to stay in contact with colleagues if you do.

LM: The hardest part was learning how to be a professor. It was a difficult, discouraging, rewarding, and lengthy process.

MD: My most difficult time was after my postdoc. I got married and my husband had a position at Cornell, but there was no position for me. We moved and we both changed fields. The next critical stage was during the early child rearing years, when I literally couldn't get to work on time. I was almost fired. I finally got a visiting appointment at MIT. Sometimes bad things happen that lead to a positive resolution, but women still have greater discontinuity than men, as a rule.

Q: If someone does fall off, is it realistic to think that person can get back on?

BW: It's easier than it used to be but it's still hard. It took me ten years to finish graduate school, so I was older when I began my career. You have to drop back a few steps. You may have to come back as a postdoc.

MD: I've mentored these people. Everyone is different, but if you are at the point of asking for help, that's half the battle. Every case was different, but every case has been successful.

Q. What about dual-career families? How do you find positions that are compatible to both parties?

CM: It's hard, and often requires a commuting marriage. We kept trying to get closer. New York–Boston was better than New Jersey–Finland. The nepotism rules are improving at institutions and corporations, but the job market is worse.

LM: One party or the other or both has to be flexible. It is very important to marry the right person.

BW: One choice is to wait before making a career or marriage move.

Q: How do you balance family and career?

CM: Again, it's important to marry the right person. You share responsibilities, but you may never see each other. For example if you use day care, one drops the child off, the other picks the child up. In our case my husband takes the child on weekends and I work at the lab. The hard part is when the child is under two—neither of you sleep.

MD: I had four children, three in diapers at one time, and those years when my home life was a zoo turned out to be my most creative years. You do it, sweat it out, get through it. There are even some positives. Your children can participate in research. My children knew how to do research by the time they were in high school. You need good childcare and good continuity. I had the same babysitter for 29 years. My children say that they had two mothers.

Q: Why bother with a career in physics when there are more comfortable ways to spend your life?

CM. Everyone faces these moments. For me, it was in grad school. I asked why I was going through all this punishment. I continued because the answer was "it's fun to do research." The inconveniences get forgotten when you are working in the lab or looking at data.

LM: I never considered another course.

BW: I tried other things. I managed a ski shop and sold encyclopedias. I would rather do this. It is tough and frustrating at times but more rewarding in general. Good times follow the bad.

MD: More than 90% of women who go through the Ph.D level persist and succeed in the field. There are periods of despair in every career. Somehow you persevere.

Q: When is the time to challenge bias? Can you challenge and stay at your institution, or is it self-destructive?

BW: I don't have a lot of experience. Bell Laboratories was very supportive of me when I was there, because top management fostered change. Still, I do small things on a daily basis to raise consciousness.

LM: This generation has an advantage: it is no longer respectable for men to hold a biased view. Most people will have the sense to be embarrassed by this type of attitude. So it does no harm, and it might help.

MD: If the complaint is made by the injured person, it may, in the long term, be held against that person. If someone more senior, best a man, serves as spokesperson it is better.

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Do science only if you can't live without it, said one audience member later in the session. Another said not to question your own intelligence if you should fail. Sometimes things are beyond your control, she said, so just try to find ways you can be happy in science.

The session ran more than an hour longer than scheduled, and participants still wanted to continue. Due to the success of this panel discussion and the keen interest on the part of the audience, CSWP will plan more of these types of events at APS meetings.

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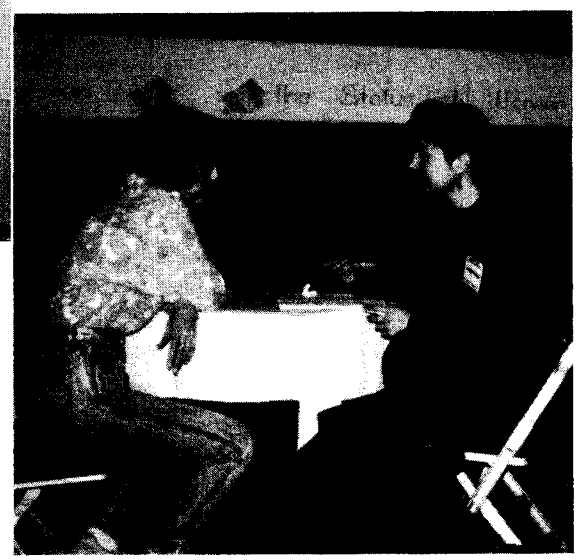

CSWP HOSPITALITY SUITES AT CINCINNATI AND WASHINGTON APS MEETINGS

The CSWP sponsored two hospitality suites this spring at APS meetings, one in Cincinnati on 17 March and the other on 21 April in Washington, DC. Both events were scheduled on the Sunday night before the start of the meetings, to give women attending the meeting a chance to get acquainted before the technical sessions got underway.

Each hospitality suite drew about a hundred attendees, including past and present APS officers and CSWP committee members. CSWP chair Millie Dresselhaus spoke at both gatherings, and APS President Nicolaas Bloembergen (in bottom photograph) addressed the Cincinnati group. CSWP literature was distributed and refreshments were served. The success of these two gatherings and the panel discussion at the Cincinnati meeting, indicate that similar events should be held regularly at APS general meetings.

MIRIAM FORMAN RESIGNS

Miriam Forman, an astrophysicist at the State University of New York Stony Brook, resigned in April from her position as Director, APS Physics Profession Programs. She had been with the Society since 1985. During her tenure as Director, APS Physics Profession Programs and as Deputy Executive Secretary, Forman served as the liaison officer to the Committee on the Status of Women in Physics.

In this capacity, Forman advised the CSWP on how to pursue and accomplish committee goals within the APS structure, kept programs and projects on track, interacted closely and constantly with committee members, carried CSWP recommendations to Council and argued when necessary for their passage, and provided support and essential continuity to the committee.

Forman's formidable energy was instrumental in many CSWP projects. She was a guiding force behind the publication of *My Daughter Beatrice*, a memoire of Beatrice Tinsley written by her father, Edward Hill. Forman's attention to obtaining and analyzing data about women in the APS, particularly through the 1990 Membership Survey, has provided a wealth of information and evidence to support of the work of the CSWP. She served on the steering committee for the November 1990 conference on the recruitment and retention of women in physics, and helped to launch the CSWP site visit program. Recently she has worked to determine and increase the numbers of women APS Fellows, and to bring more women into positions of influence in the Society.

In addition to her work with CSWP, Forman performed other valuable services for the APS. She was liaison officer to the Committee on the International Freedom of Scientists, the Committee on Membership, and the Committee on Minorities, and represented APS on numerous external panels and commissions. She was involved in release activities for the Directed Energy Weapons Study, and in organization and planning for the 1986 International Meeting, held in conjunction with the APS Spring meeting and attended by representatives of the world's physical societies. She played a key role in the organization (on very short notice) of the April 1989 sessions on cold fusion. She assisted the Task Force on Electronic Information Systems in their analysis and report on the future of electronic publishing for the APS.

This list of Forman's contributions is far from complete. CSWP members and the broader community of women in physics owe Miriam a debt of gratitude and will miss working with her, as will other APS members and staff. All wish her success in her new career pursuits, and thank her for her many years of service to APS.

APS Associate Executive Secretary Brian Schwartz will serve as interim CSWP liaison officer, until a replacement for Forman is found.

LUISE MEYER-SHUTZMEISTER AWARD TO GAIL DODGE

Ms. Gail Dodge of Stanford University is the 1991 winner of the Luise Meyer Schutzmeister Award. The award commemorates the career of a former senior physicist in nuclear spectroscopy at Argonne National Laboratory, and goes to an outstanding woman candidates for a physics PhD, studying at a university in the United States.

Ms. Dodge provided the following autobiographical sketch.

"I became interested in nuclear physics during my undergraduate work at Princeton University. For my senior thesis I worked with Professor Art McDonald on the Princeton cyclotron to measure the branching ratio for gamma decay of the isobaric analog state of ^{71}Ga in ^{71}Ge using the reaction ^{71}Ga(^{3}He,$t\gamma$). This reaction was studied for its relevance to a proposed gallium solar neutrino detector. My interest in nuclear physics developed further during a summer job at the Lawrence Berkeley Laboratory, where I worked on an EGS simulation of a proposed Total Absorption Spectrometer under the supervision of Dr. Mike Nitschke.

After graduation from Princeton in 1986, I began graduate work at Stanford, and by the end of my first year joined the experimental nuclear physics group under the guidance of Professor Stanley Hanna. My dissertation is a study of proton decay from the giant resonances in ^{12}C as a function of momentum transfer. We excite the giant resonance with electrons at the MIT-Bates Linear Accelerator Laboratory. In these experiments we measure angular correlations of decay protons detected in coincidence with scattered electrons. The angular correlations are important since they give direct information on resonances of higher multipolarity, resonance interferences, and the structure of the giant resonance. We plan to continue this work during the next year by using polarized electrons and measuring, for the first time, a fifth response function proportional to the polarization.

With other members of the Stanford group, I have had an opportunity to work on a variety of experiments in addition to my thesis, including muon capture on ^{3}He at TRIUMF, pion single charge-exchange excitation of isovector resonances at LAMPF, and a measurement of $\pi^+ p \rightarrow \pi^+ \pi^0 p$ near threshold at LAMPF to determine the $\pi\pi$ scattering length. I expect to complete my Ph.D. in December 1991, and go on to a postdoctoral position."

Applications for the Meyer-Schutzmeister Award can be obtained by writing to Professor Gerald Hardie, Dept. of Physics, Western Michigan University, Kalamazoo, MI 49008-5151. Applications are due, along with transcripts and recommendations, by a mid-January deadline, indicated on the application.

"LIVES OF WOMEN IN SCIENCE" BOOK SERIES ANNOUNCED

A new book series on "Lives of Women in Science" has been announced by Rutgers University Press. The Press invites proposals and book-length manuscripts for a series of original biographies of women whose scientific work was memorable and whose lives epitomize the complexity of issues that have faced any woman choosing a career in science. The books are intended for the general public, scientists, students, and scholars in women's studies, history, and history of science. Contributions are also invited to two volumes of essays planned for the series: Creative Couples in Science and Gender and Patronage in Scientific Careers. Send inquiries and proposals to Dr. Pnina Abir-Am, c/o Karen Reeds, Science Editor, Rutgers University Press, 109 Church St., New Brunswick, NJ 08901; telephone (201) 932-8174; FAX (201) 932-7039.

MICHAEL LEVIN REPLIES TO PROFESSOR RUSKAI

Sex-differentiated performance on valid tests of mathematical ability is a commonplace of the psychometric literature. To this commonplace, Professor Ruskai[1] opposes a reanalysis by Hyde *et al.*[2] of male/female score differences on 259 tests, international data on test of eighth graders,[3] and critical commentaries on a review article by Benbow.[4] These sources, when consulted, do not support doubt.

The Hyde *et al.* meta-analysis found an average size difference d of 0.2 between male and female performance, $d =$ (the male mean − the female mean) × $1/\sigma$— when the variance for males and females is assumed identical — and a d of 0.15 when SAT-M scores are discounted (see below). Both figures are taken to be small. However, many of the tests surveyed measure computational ability, and, as noted in my letter, females do as well as males on the algorithmic mathematics taught in the lower grades. Computation is not insight into abstract structure, and female algorithmic competence may instance the widely observed female superiority at detailed, routine tasks. When the mathematical content of the tests and the age and selectivity of the test-taking population was controlled for, d rose to 0.41 among 19–25 year olds and 0.54 among highly selected test-takers.[2] Since the international data concern eighth-grade children, it too ignores the post-pubertal phasing of the male mathematical advantage. In any case, the primacy of "cultural factors" in performance cannot be shown by the different d's of genetically diverse populations, since this between-group difference itself may be partly or wholly genetic in origin. (There is, for instance, some evidence that Negroid variance in general intelligence is less then Caucasoid;[5] a relatively smaller Negroid d would follow from the heavy g-loading of mathematical ability.) In no case is d negative with respect to nonalgorithmic mathematics for the males and females of the same population. Nor do large between-population differences alter the significance of smaller male/female within-population differences. Between-group differences in size exceed average sex differences in size within groups, yet the men of every group remain larger than the women of that group and assume charge of tasks for which size is important.

Note, incidentally, that even a d of 0.2 carries high-tail effects that would explain much of the male dominance of mathematics. If $=\sigma_F(X)=\sigma_M(X)$ and $\mu(X,M)=\mu(X,F)+0.2\sigma$ for two populations F and M, there will be almost twice as many M's as F's at $X=\mu+3\sigma$. Differences in variance enhance this effect; if d (in terms of averaged variances) = 0.2, while (say) $\sigma_F=14$ and $\sigma_M=16$, there will be about $4\frac{1}{2}$ times as many M's as F's at $X=1.5\times(\sigma_F+\sigma_M)$ — three average SD's out. A more realistic d near 0.4 multiplies these effects further. Also, on the question of high-tail dominance, Professor Ruskai appears to conflate the SMPY study with the Center for the Advancement of Academically Talented Youth study, perhaps because both are located at The Johns Hopkins University. The CTY sample is smaller than SMPY's and not as rigorously controlled for age; the SMPY ratios have been quite stable over time.[6]

The tails of curves with properly separated means may still not model observed sex ratios in the mathematical sciences, but they may suffice to trigger the feedback described by Goldberg[7] and mentioned in my letter. Successful "scientists" (those responsible for a society's technology) are recruited from the high tail of mathematical talent. The initial male predominance in this conspicuous cohort creates the society-wide expectation that "science is for men," an expectation that causes some girls with sufficient mathematical talent to avoid a scientific career. The resulting increment in proportional male dominance science confirms the expectation and steers more girls away from science, ... Far from being a "nonstandard" statistic, high-tail ratios (whether an effect of mean differences, differences in variance, or both) are thus essential for understanding male "overrepresentation" in science, and analogous social phenomena. This same dynamic, for instance, may control the black near-monopoly in American basketball. Black dominance of the sport immediately after its integration suggests some innate black advantage in the relevant skills. The ensuing perception of basketball as a "black" sport may then have caused some sufficiently talented whites to avoid basketball, confirming the perception ... Correlatively, whites choosing to pursue an activity like basketball stereotyped as inappropriate must be exceptionally able and highly motivated; this corollary applied to mathematics may explain the slightly higher calculus grades of the relatively few females who take calculus.

Not being a moralist, I do not understand the idea that this dynamic is "bad," or that women with sufficient mathematical talent "ought" to become physicists. Like all else in nature, people respond to the forces acting upon them. (The preoccupation of adolescent girls with popularity and appearance is caused by the need to select a mate, biologically a more consequential decision than for their male counterparts and a force not to be ridiculed.) Female participation in science has lately increased, in part because of altered social norms, a change that delights some and appalls others. I prefer a juristic perspective, observing that those potentially able women who avoid science have not been coerced or injured, since the cause acting on them— the feedback loop— was not designed by a malevolent agency. Not having been injured, women do not deserve special attention as a matter of compensatory justice, as it is often argued that they do. Nor is there a "natural" number of female scientists in any society, any more than there is a natural number of white basketball players.

Returning to empirical matters, the main evidence for a large *d* remains the male/female discrepancy on SAT-M tests, particularly (but not exclusively) in the SMPY study. Professor Ruskai suggests that the critical commentary on Benbow's review undercuts the SMPY study, but this commentary, in fact, shows the reverse. The point is worth exploring, since it typifies many of the confusions surrounding sex differences.

By my count, 38 of the 42 commentators *agree* that SMPY shows a significant sex difference in mathematical ability. Typical comments are: "convincing evidence of significant test-related differences in mathematical reasoning ability among intellectually talented students" (Burnett); "it is hard to defend the position there is no real gender difference here" (Kennick); "persuasive if not definitive" (Mackenzie); "thoroughly compelling" (Rosenthal); "highly reliable evidence" (Smothergill). The subjects about which many of these authors do express reservations are the *physiological basis* of this difference, and, to a lesser extent, the components of mathematical ability, such as spatial visualizing. Much speculation has centered on cerebral lateralization, since (a) the left cerebral hemisphere controls verbalization while the right hemisphere controls spatial visualizing, and (b) the *corpus callosum*, the physical bridge between the hemispheres, is thinner in males than females. What is more, mathematical ability correlates with such undoubtedly neurophysiological phenomena as left-handedness. It is natural to suppose the male brain more lateralized, with the right hemisphere dominant, yet—as Benbow's commentators observe—the data by no means dovetail into a neat pattern. (It remains unclear, for instance, why lateralization should produce *right*-hemispheric dominance.) But these uncertainties cast no doubt on a biological basis for the sex difference, since one can have overwhelming evidence for the existence of a mechanism without knowing what that mechanism is. That something passed traits from parent to offspring was clear before anyone ever heard of DNA. The deflection of magnets by passage of a current was clear before anyone knew what magnets or currents are. As Diane McGuiness writes, "One does not need to locate the sex difference on a particular gene" to make a "valid argument" that that difference exists. So long as environmental variables are controlled for, differential responses to a test instrument is such an argument.

The few dissenting authors, like Professor Ruskai, do deny that SMPY contains proper controls. Here it is crucial to distinguish, as these critics often do not, the sheer *possibility* of a hidden environmental variable from the *reasonableness* of supposing one at work. One writer suggests that girls might underperform on tests of spatial ability using lighted screens because they are anxious at being alone in the dark with a man! Other writers note the self-selectedness of the SMPY sample, but offer no evidence that significantly many females as able as the best males decide against participating. Professor Ruskai suggests that mention of the sex difference in the SMPY promotional literature may introduce invalidating bias; this seems less than compelling intuitively, and overlooks the fact that Benbow and Stanley discovered the sex difference serendipitously when examining the initial SMPY data for which $n = 9227$.[8]

Methodologically, explanations of sex difference in terms of cultural expectations are inherently incomplete because they are unable to explain these expectations themselves. Why are parents more apt to believe their sons better at mathematics than their daughters? "Because of stereotypes" leads in a circle. Expectations existing at a later time can be produced by expectations existing at some earlier time, but there must have been some first expectation, produced by some presocial factor. Women may not have been welcome in physics labs until recently, but this disfavor must be explained by something beyond "culture," which just designates the totality of such beliefs and attitudes. In this last connection it should be recalled that the greatest breakthroughs in physics, such as the thought experiments of Archimedes, Stevinus, and Galileo, Newton's derivation of Kepler's laws, or Einstein's use of the Lorentz transformation, did not involve apparatus at all, but insight into data widely—sometimes universally—available. That such advances were all made by men cannot be explained by the shibboleth that "only men were allowed into the laboratory."

Those who wish to see "more women in science" are naturally sensitive about standards and the accusation of playing a numbers game. I agree that Janice Button-Shafer doesn't explicitly call for 50/50, but her use of epithets like "only" and "still low" for proportions like 12% and 15% suggest that little short of 50/50 will satisfy her. I am not surprised that MIT denies a lowering of standards; what are they supposed to say? Generally speaking, policies designed to "get more women [blacks, Hispanics] into *X*" face an intractable dilemma. If the women chosen under the policy would have been selected anyway by a best-first, next-best-second, . . . criterion, the policy was unnecessary; if the women chosen would not have made a top-down cut, the policy conflicts with merit. Should girls be given special training to enable them to meet merit criteria, equity requires special training for boys as well, which, barring threshold effects, would leave sex ratios constant. One also encounters the need for more physicists as a reason for seeking to recruit more women. Surely, however, the proper way to increase the number of physicists is to expand facilities for training physicists and admit more students, perhaps by lowering standards—for everyone—just a little. If women are better represented closer to the mean, such a policy would naturally sweep more women in. (Of course, the marginal return on the training of decreasingly qualified candidate physicists will eventually become too small.) What makes no sense whatever, if more physicists are needed, is any diversion of resources from the most promising students of whatever sex. To her credit, Professor Rusaki avoids any patent inequities, preferring an overall improvement in math and science education which she evidentally hopes will close the gender gap and at "the worst" produce better male scientists—a turn of phrase I trust is meant humorously.

Professor Ruskai could not be farther wrong, however, in presuming the media biased toward innatism. It has been received wisdom for a quarter of a century that men and women differ not at all, or if they do, their differences are due to "sexist conditioning." Thousands of books and articles have repeated this baseless claim. The few articles that do deal with innate sex differences treat the topic as a man-bites-dog novelty, which, the reader is hastily assured, is no threat to egalitarian enlightenment. Environmentalist experts are always on hand for instant rebuttal. Moreover, heavy penalities attach to bucking this orthodoxy. The reader might be interested to know that a committee convened by the President of City College examined my original letter to the *American Journal of Physics* to determine whether it had exceeded the bounds of academic freedom to become "conduct unbecoming a faculty member," the language which triggers disciplinary proceedings. Since the members of the Royal Society are presumably aware of the adverse consequences of recognizing innate sex differences, their pronouncements on the subject may be taken *cum grano*.

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[1]M. Ruskai, "Response to a letter from M. Levin," Am. J. Phys. **58**, 11–14 (1991).
[2]J. S. Hyde, E. Fennema, and S. J. Lamon, "Gender differences in mathematics performance: A meta-analysis," Psych. Bull. **107**, 139–155.
[3]G. Hanna, "Mathematics achievement of girls and boys in grade eight: Results from 20 countries," Educ. Stud. Math. **20**, 225–232 (1989).
[4]C. Benbow *et al.*, "Sex differences in mathematical reasoning ability in intellectually talented preadolescents: Their nature, effects, and possible causes," Behav. Brain Sci. **11**, 169–232 (1988).
[5]L. Gottfredson, "Societal consequences of the *g* factor in Employment," J. Voc. Behav. **29**, 379–410 (1986).
[6]Julian Stanley, personal communication (1991).
[7]S. Goldberg, *The Inevitability of Patriarchy*, 2nd ed. (London, 1977).
[8]C. Benbow and J. Stanley, "Sex differences in mathematical ability: Fact or artifact?," Science **210**, 1262–1264 (1980).

[Margarita Levin's letter, below, was received while her husband, Michael Levin, was awaiting resolution of the committee review at City College, described in the last paragraph of his response. Her first sentence refers to his having withheld the above response until the review had been completed— Asst. Ed.]

A LETTER TO THE EDITOR

My husband is temporarily unable to respond to Ruskai's and Tobias's criticism in the *Gazette* of April 1991, but since the latter has dragged me into the discussion, I will take the opportunity to respond here.

Since credentials have been cited, let me state that I have a bachelor's degree in mathematics, and a Ph.D. in philosophy of mathematics. I teach mathematical logic and set theory, and I am, for the record, Hispanic.

Now let me say that while Ms. Tobias at least sticks to the point at issue in the first few paragraphs of her remarks, she commits numerous textbook logical fallacies thereafter.

(1) An argument should be criticized on its merits, not on the basis of who is making the argument or who he is married to.

(2) An argument should be critisized on its merits, not on the basis of what its proponent has said elsewhere on other topics.

(3) Also irrelevant is what censures or disagreements the proponent of the argument may have encountered on other topics.

The fair-minded reader will please ask herself what she would have thought of Michael Levin, in responding to either Ruskai or Tobias, had he cited evidence that one can't balance her checkbook or that the other believes in a return to the gold standard. Indeed, resort to personal attacks suggests the absence of any well-founded criticisms.

Incidentally, Ms. Tobias does not seem to notice how revealing is her claim that talented girls dropped out of the mathematical program because the boys were "nerdy." If so, this surely suggests that for those girls their social life mattered more than their mathematical education.

There is a fundamental difference in the way feminists and their critics view the gap in mathematical abilities. The critics believe that the evidence points to a genetic factor, but they are quite capable of imagining experimental evidence that would change their belief. If altering the environment actually produced a much larger number of women with superior mathematical ability, if the number of significant theorems by women suddenly increased, we would, other things being equal, concede we were refuted. But, I predict, one will never see feminists such as Ruskai and Tobias describe experimental evidence which would convince them that the male/female difference is significantly genetic in origin. I need not remind an audience of physicists that a hypothesis treated as unfalsifiable is not a scientific belief but an article of faith.

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Supporting information should include at least one letter of nomination and a current curriculum vitae of the nominee. Additional supporting letters are helpful. Send names of proposed candidates and supporting information before 1 September 1991 to Ronald F. Stebbings, Chairperson, Maria Goeppert-Mayer Award Selection Committee, Department of Physics, Rice University, Box 1892, Houston, TX 88251.

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