A Scientific Point of View

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If the physics community is serious about increasing the number of women in physics, we need to start thinking like scientists.

Twenty-five years ago I was the only female among 10 physics majors in my class, and there were no women on the physics faculty. Much of what I heard back then sounds painfully similar to what I'm hearing today—there was a general consensus that the lack of women in physics was a problem but that things were getting better and the numbers would soon increase.

I have to admit that as an undergraduate and beginning graduate student in physics I was happily immersed in the subject matter and not particularly interested in the issue of women in physics—and I owe an apology to some of my fellow graduate students who tried unsuccessfully to convince me that gender bias was a very real problem. I wanted to be a physicist, not a woman physicist, and the fact that I was female was, I thought, about as relevant to my future as my red hair.

I was wrong. I was almost through graduate school before I was even willing to concede that gender biases existed. More recently I realized that the most frustrating aspect of the persistent small numbers of women in our field is that as physicists we are not applying the same incredible problem-solving skills that we have used so successfully to address other complex problems.

The latest American Institute of Physics data reveal that in 2002 women represented 5% of full professors in physics (up from 3% in 1998) and the overall percentage of women physics faculty at all levels, including non-tenure-track, is 10%. While the number of women hired into faculty positions is commensurate with the available candidate pool—the leaky pipeline appears to be fixed at the graduate school and faculty levels—the numbers themselves remain embarrassingly low. Other professions and academic fields have made much greater advances over the same 25-year period, and the gap continues to widen. We have been left far behind the physicians, lawyers, biologists, and most of the physical sciences. (See the "Further reading" list on page 65.)

Further, the AIP data indicate that the distribution of women among physics faculty is skewed, with higher percentages in non-tenure-track positions and in departments that do not grant graduate degrees. Salaries for female physicists are lower than those of their male colleagues with the same number of years' experience working in the same employment sector. The authors of the report, Rachel Ivie and Kim Nies Ray, also stress that their data do not identify additional gender-specific challenges that women faculty members may face.

There is no question that the paucity of women in physics is a complex issue, with many societal and cultural aspects that are beyond the ability of any individual or institution to completely transform. That is no excuse. Physicists eagerly plunge into even more complex questions. If we really want to increase the number of women in physics, we need to approach this problem in the same way we attack our physics problems. We need to read the literature, talk to the experts, carefully frame the relevant questions, and conduct a careful and well-designed experiment.

The AIP data suggest a starting point: Although 46% of high-school physics students are female, women earn only 23% of bachelor's degrees in physics. Unless we get more women into the pipeline at the undergraduate level, we can never hope to achieve parity at the faculty level.

Ivie and Ray note that the small percentage of women physics majors may be due in part to decisions made by young women before they enter college, decisions influenced by cultural attitudes that view science, and physics in particular, as an essentially masculine endeavor. This possibility generates a response from some of my fellow physicists that would appear to absolve the physics community from further action: Given such overwhelming and pervasive cultural influences, how can we ever hope to understand the reasons why boys and girls take different paths, let alone seek to remedy any inequities that might exist?

One might ask the same question of those audacious characters who conduct neutrino experiments or the search for cold dark matter. Such studies must also operate in the real world in which an unavoidable cosmic-ray background swamps the expected signal. It isn't easy—backgrounds must be well understood and properly accounted for during data analysis—but if we can detect neutrino oscillations, we can surely take on the question of why so few women go into science.

Research by Yu Xie and Kimberlee Shauman offers further insight into this question. Their data support a large gender gap in career goals among high-school seniors—half as many girls as boys plan to major in science in college—but also indicate that young women entering college are not as strongly recruited into science and engineering fields nor as successfully retained as young men. High-school girls whose stated goal in college is a science degree are only one-third as likely as their male counterparts to continue in science through the bachelor's degree, and twice as many boys as girls switch from a non-science major expectation in high school to a science major in their first year of college. It is also interesting to note that more than half of all girls who do earn a bachelor's degree in science make such a switch from a non-science to a science major.

Detectors and data analysis

Consider a *gedanken* experiment designed to select the next generation of physicists. Ideally we want to identify and attract outstanding and creative minds from all the potential candidate pools.

The first rule of any good experiment is to thoroughly understand your detector. Attempting to interpret data without correcting for known biases and accounting for systematic errors is simply bad science. In our experiment, each of us is a detector and the data we accumulate are used to make decisions about the potential of students, postdocs, and colleagues. These data are used in hiring new faculty, accepting graduate students, and simply deciding whom to encourage at various

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points in their academic careers.

Although each of us would like to think her or his detector is unbiased, the simple fact remains that no detector is perfect. That includes yours—and mine. Studies show that both men and women respond to and evaluate males and females differently and that they are usually unaware of how strongly their perceptions and actions are affected by gender bias.

We also need to understand the variables that influence the interpretation of the data. Some of these variables are, in a sense, hidden. Explicit variables include grades and test scores, or—for more advanced candidates—publications, citations, and invited talks. Hidden variables include perceived confidence and aggressiveness. Unfortunately these are also variables for which it is especially difficult for women to obtain sufficiently high ratings. In our culture girls are, in general, actively discouraged from developing those attributes. Further, women face a fine-tuning challenge in successfully projecting the right amount of confidence and aggressiveness; only an extremely narrow range of behavior is viewed positively.

Logical next steps

What next? First look at the evidence, both nationally and within your own department. (Although my suggestions are aimed at the academic community, they can be generalized to other work environments.) Institutions that award fewer than about 40% of bachelor's degrees to women should be actively investigating to find out why. Those with significantly less than the national average (about 23%) should make increasing this percentage a top priority. Determine if and at what point women at your institution are choosing not to enter physics or to drop out; do you need to focus on recruitment or retention or both? Similarly, assess how well your graduate program is doing. Departments should be required to report statistics on women and minorities at least every two years, and those numbers should be published and available to prospective students and faculty. I also strongly urge the physics community to conduct a longitudinal study of women in physics similar to that endorsed by the American Astronomical Society.

Second, pick up a book (the second and third entries in "Further reading" are great places to start) or an article on the effects of gender bias. Much has been written about that issue, but it appears to me that little has been read by physicists—and less has been acted upon. A wealth of literature documents the generic characteristics of human detectors with respect to gender bias, the cultural "backgrounds" and issues specific to women in science, and techniques that can minimize the effects of these—the equivalent of putting your detector deep underground.

Invite experts—for example, someone from an NSF Advance program—to speak at your institution. And listen to them. Seek out programs that are having a positive impact at other institutions. Find out what's working and what isn't. Some departments, and some individuals, have achieved incredible results, evidence that actively working to attract and retain women at all levels from undergraduate to faculty can be successful.

I won't argue with those who want to transform the physics landscape in ways that will benefit both the science and the scientists, male and female. However, I do feel strongly that women as a group do not need special treatment, they need equal treatment. And we need to be aware that the playing field is not yet level. An excellent article by Anna Fels outlines two key ingredients in successfully realizing one's ambitions. First is mastery of a special skill set; second, and equally important, is receiving an appropriate level of recognition and approval. It is this second ingredient that we do not distribute equally. Beginning in our freshman physics courses, we need to identify promising young women and we need to encourage and support them at all stages of their careers just as we do promising young men. In addition to institution-wide changes, we each need to be aware that informal interactions are also critical. Make sure that you personally encourage both male and female students to attend a seminar, apply to graduate school, or take a particular course. Include interested students of both genders in informal discussions about a recent talk or new results. And make sure that all of your students are well trained in giving talks and are comfortable speaking up in classes and seminars. They should be aware that these are important components of how science is currently done, and how they will be judged.

I am confident that if we really want to, we can make much more and much faster progress than we have over the past 25 years. I suspect that the hardest step is to truly understand and accept that we all have flawed detectors, no matter how good our intentions, and that this is not an insurmountable problem—in fact, it is a very familiar one. And we need to get busy. The polarization of the cosmic microwave background did not measure itself—and the numbers of women in physics will not increase significantly until we begin to approach the question with the same enthusiasm and skill. ■

Further reading

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▶ M. Fehrs, R. Czujko, "Women in Physics: Reversing the Exclusion," PHYSICS TODAY, August 1992, p. 33.

▶ NSF Advance program sites listed at http://www.nsf.gov/crssprgm/advance/itwebsites.jsp.

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