Women in Physics in the United States: A Progress Report

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Looking back over the past half century, women have made extraordinary progress in terms of their participation in physics in the United States. In the last decade alone, the percentage of women earning a Ph.D. in the United States has gone from 11.3% in 1994 to 13.0% in 2001 and a record high of 18.0% in 2003.[1] In 2003, women also accounted for fully 21% of the newly enrolling physics graduate students in the U.S., indicating that the numbers receiving Ph.D.s may continue to increase. However, some interesting trends underlie these data. For example, the percentage of U.S. women who received Ph.D.s in 2003 still hovered around the 13.0% mark. Yet, what seems to be a recent dramatic increase of women physicists was driven, in part, by the large participation of foreign women in Ph.D. programs in the U.S. It is also true that the actual *number* of Ph.D.s awarded to women between 1994 and 2001 decreased, but this was offset by an even larger decrease in the number of such degrees awarded to men. The numbers of women receiving Ph.D.s increased in both 2002 and 2003. Finally, while women's participation in physics has been steadily increasing, it still lags behind the increases seen in other physical sciences, with the exception of engineering, which shows a trend similar to physics.

U.S. women of non-European descent are particularly underrepresented in physics. These women of color (WOC) face particular challenges of invisibility and alienation in U.S. physics. For example, between 1995 and 2001, of approximately 3800 physics bachelor degrees awarded annually, African-American and Hispanic women were granted an average of only 1.5% and 0.6% each year, respectively. At the Ph.D. level, between 1997 and 2003, of approximately 1100 degrees awarded each year, African-American and Hispanic women received an average of 0.5% degrees annually. In 2001, no Ph.D.s in physics were granted to Native Americans or Native Alaskans.[1] Not surprisingly, representation of WOC also suffers in academia. This fact also applies to Asian-American women, who are generally better represented at the bachelor's and Ph.D. levels in physics. According to a 2002 survey conducted by Donna J. Nelson, in the "top 50" U.S. physics departments, only 23 Asian, 8 Hispanic/Latina or Chicana, and *no* African-American, Native-American, or Native-Alaskan women were reported as faculty members.[3] Clearly, in the specific context of physics, there is an interaction between race/ethnicity and gender that works to exclude WOC.

Further interesting trends for U.S. women physicists in academia emerge in the AIP study.[1] In an examination of the "pipeline" in physics, the report notes that women disproportionately leave physics between completion of high school and receiving an undergraduate degree. Less than one-fourth of physics bachelor's degrees are awarded to women while they make up nearly half of high school physics students. Despite their high participation in high school physics they are a smaller percentage of the group of students that takes the Advanced Placement (AP) physics exam.[1] Clearly, university and college physics departments need to pay closer attention to fostering a welcoming environment and to improving undergraduate curricula and instruction in order to retain more young women at this critical point in students' education. Fortunately, the gender gap is diminished once the students move on to graduate level, where retention rates for men and women are similar. Some of the most encouraging news in the study is the percentage of women pursuing academic careers in 2002, where their representation at various stages of the academic ladder—5% of Full Professors, 11% of Associate Professors, and 16% of Assistant Professors—is commensurate with past degree

production. However, among the top 50 NSF-ranked science and engineering departments, physics had one of the three lowest percentages of female assistant professors in elite departments: 11.2%, compared with the national average of 16%.[3] For women in astronomy the situation is better with 26% of Ph.D.s awarded to women and nearly double the percentage of women faculty in astronomy at each academic level, as compared with Ph.D. recipients in prior years (10%, 23% and 23% respectively, 2003).[1] In 2001, women comprised 13% of the physical and related sciences Ph.D.s working in business or industry and approximately 11% of the physical and related sciences Ph.D.s working in the federal government.[2]

Given the undeniable progress that women in physics have made in the U.S., there are still challenges that remain to be addressed. Among the group of employed science and engineering doctorate holders in 2001 women are less likely to be married (67.2% of women vs. 83.2% of men), although they are also twice as likely to be divorced (11.8% vs. 5.8%). Women are approximately twice as likely to have a spouse who is employed full time (84.4% vs. 45.9%) and the majority of these spouses have technical careers requiring at least a bachelor's degree (50.2% vs. 31.1%).[1] This means that the dual technical career or "two-body problem" has a disproportionate effect on women pursuing careers in physics. Even though the statistics presented discuss marriage in particular it is reasonable to generalize this issue to women physicists trying to balance a personal relationship with the desire to have a successful career. A number of strategies have been proposed to address this issue including split positions, spousal hiring programs, alternative academic positions, and long-distance commuting.[4] Although many societal pressures may underlie these issues, including the still-prevalent view of women as the primary caregivers in a family (caring for children, aging parents, a spouse or partner) and the unfortunately persistent myth that women have less intrinsic aptitude for science and math ("hard" sciences), the fact is that technical careers have a different impact on the lives of women who pursue them relative to their male colleagues.

Women of color in the U.S. face additional challenges in studying and working in the predominantly white male environment of physics. As undergraduates, they often lack opportunities to do research and are unlikely to encounter WOC role models. Further, they frequently sense that they are not considered competent or intelligent because their physical appearance does not comply with prevalent images of the "standard" physicist.[5] At the graduate level, African-American, Hispanic, and Native-American women (among others) often do not persist in science because they receive no encouragement, which can effectively "produce the same result as active discouragement."[3] Among those who *do* receive Ph.D.s, their alienating graduate school experiences often lead them to seek employment outside of academia.[7] The AIP study states, "Minority women especially represent a great, untapped resource."[1] To draw on this resource, much greater attention and effort are needed to recruit, retain, and serve minority women in physics.

It is now generally recognized that the future health of physics in the U.S. depends on ensuring that *all* capable and interested students are invited, encouraged, and helped to see the broad range of careers they can pursue with a physics degree. It is especially urgent to cultivate the talent and ideas of women, minorities, and others who are traditionally underrepresented and underserved in physics.

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