Women in Physics in the United States
(numbers, challenges, solutions)

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FOR FURTHER INFORMATION

American Institute of Physics Statistical Research Center:  www.aip.org/statistics/

American Physical Society Gender Equity Report:  
www.aps.org/programs/women/workshops/gender-equity/

Univ. of California Faculty Family Friendly Edge (including articles by Prof. Mary Ann Mason)  ucfamilyedge.berkeley.edu/

The Gender Equity Project (including articles by Prof. Virginia Valian):  
www.hunter.cuny.edu/genderequity/

Women Don’t Ask [Negotiation and the Gender Divide]:  www.womendontask.com/ 
Ask for It [How Women can Use the Power of Negotiation...]

National Science Foundation ADVANCE Program:  www.nsf.gov/crssprgm/advance/ 
ADVANCE Portal Website:  www.portal.advance.vt.edu/ 
Michigan State’s ADAPP-ADVANCE Project:  www.adapp-advance.msu.edu/
The Numbers
Between 1987 and 2009, the number of girls taking physics in US high schools increased 161%, while the number of boys was up 88%. (See Figure 1.)

Proportionally, about 40% of high school physics students were female in 1987. This went up to about 47% in 1997 and has been remarkably consistent since. (See Figure 2 on the following page.)

The number of girls taking physics in high school is up, but growth is slower in advanced physics classes. The under-representation of girls in more advanced high school physics classes can have implications that extend well beyond a student's high school career.

In this report, we will examine female representation by type of physics class, with a closer look at female representation in AP Physics. We will consider the implications of the lower representation of females in advanced high school physics classes.

http://www.aip.org/statistics
The high school physics experience can affect a student's future academic path. Perhaps the lower representation of female students is a by-product of the quantitative nature of the AP Physics B and AP Physics C courses. In order to examine this hypothesis, we looked at the data for students taking AP tests in 2009.

In the AP data, we can examine two measures of female representation: females among students taking the exam and females among students passing the exam. If the quantitative nature of the course discourages female participation, courses with comparable levels of mathematical rigor should have comparable representations of females.

Overall, almost 2.9 million tests were taken in all subjects, and over half of these (55%) were taken by female students. About 1.7 million "passing" scores were posted, 52% by female students. Looking at the representation of female students among Physics First students, we see that the percentage of female students has increased from 46% in 1993 to 52% in 2009.

Figure 3

Women Physicists Speak Again by Rachel Ivie and Stacy Guo, 2006; for preliminary updated data, see Global Survey of Physicists by Rachel Ivie and Casey Langer Tesfaye, 4th IUPAP Conference on Women in Physics, 2011

* Includes data for both Physics First and Conceptual Physics for 2009; Physics First data was not collected separately in 1993

http://www.aip.org/statistics
Do you have to take physics in high school to succeed in physics later?

- FACT: 93% of physics bachelor’s degree recipients in 2007 took physics in high school.
- FACT: Only 70% of the 2007 physics bachelors who started their undergraduate education at a 2-year college took a high school physics class.
- 9% of the 2007 physics bachelor’s degree recipients started their undergraduate education at a 2-year college.
Percent of Bachelor's Degrees Earned by Women in Selected Fields, 1966-2009

National Center for Education Statistics. Data for class of 1999 were not available.

Compiled by American Institute of Physics Statistical Research Center
Percent of PhDs earned by women in selected fields, 1958-2006

AIP Statistical Research Center. Compiled from data collected by National Science Foundation.
<table>
<thead>
<tr>
<th>Year</th>
<th>All Physics*</th>
<th>Elementary Particle Physics</th>
<th>Atomic, Molecular &amp; Optics</th>
<th>Condensed Matter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total N</td>
<td>Female %</td>
<td>Total N</td>
<td>Total N</td>
</tr>
<tr>
<td>2004 to 2006</td>
<td>3879</td>
<td>16</td>
<td>551</td>
<td>667</td>
</tr>
<tr>
<td>2000 to 2003</td>
<td>4591</td>
<td>15</td>
<td>557</td>
<td>768</td>
</tr>
<tr>
<td>1996 to 1999</td>
<td>5484</td>
<td>13</td>
<td>687</td>
<td>884</td>
</tr>
<tr>
<td>1992 to 1995</td>
<td>5829</td>
<td>12</td>
<td>682</td>
<td>822</td>
</tr>
<tr>
<td>1988 to 1991</td>
<td>4884</td>
<td>10</td>
<td>652</td>
<td>618</td>
</tr>
</tbody>
</table>

* Not including astronomy & astrophysics
Source: AIP Statistical Research Center; Compiled from data collected by the National Science Foundation.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Full Professor</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>10</td>
<td>11</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>17</td>
<td>16</td>
<td>17</td>
<td>22</td>
</tr>
<tr>
<td>Instructor/Adjunct</td>
<td>N/A</td>
<td>16</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Other ranks</td>
<td>13</td>
<td>15</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Highest Degree Offered</th>
<th>1998</th>
<th>2002</th>
<th>2006</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>6</td>
<td>7</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Master's</td>
<td>9</td>
<td>13</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Bachelor's</td>
<td>11</td>
<td>14</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
</tr>
</tbody>
</table>
The “scissors plot” summarizing these results reveals a “leaky pipeline” for women physicists. This is a problem for Physics!
Challenges and Solutions

As the NSF ADVANCE website notes:

... women’s representation and advancement in academic STEM positions are affected by many external factors that are unrelated to their ability, interest, and technical skills...
Implicit Bias

The Gender Equity Project, Virginia Valian

• We are all (women and men) prone to unintentional bias
• This affects many decisions we make in the course of our professional duties
• Relevant concepts include:
  – gender schemas
  – accumulation of disadvantage
  – stereotype threat
What are Gender Schemas?

- Gender schemas are hypotheses about what it means to be male or female.
- We all - male and female alike - share these hypotheses.
- Schemas assign different psychological traits to males and females (Martin and Halverson, 1987).
Gender Bias in Peer Review

Although women constituted 46% of the applicant pool, they received only 20% of the fellowships.

Study of the peer-review system of the Swedish Medical Research Council postdoctoral fellowship program. (Wenneras & Wold, 1997)

- Developed a model of "total impact points", which took into account productivity and prestige of the journals the applicant published in.
- Women had to receive 100 or more impact points to get the same rating from the judges that a man with 40 or fewer impact points.
- This model found that, in addition to productivity, gender had a significant influence on the scores.

IMPACT: Women have to meet a higher standard in order to receive the same recognition that men do.
Accumulation of Disadvantage

Martell, Lane, and Emrich's (1996) model assumed a tiny bias in favor of men, which accounted for only 1% of variance in promotion.

Operating at a systematic minute disadvantage can have substantial long term effects.

After many iterations the top level was 65% male.
There are 189 such departments and the median number of faculty is 25.

What is it like to be 1 woman in a faculty of 25?
• **solutions** include:

* leaders emphasize importance of diversity for achieving institutional goals
* institutions make criteria and processes for hiring, tenure, promotion, awards clear and easily available to all
* departments frame faculty searches broadly
* hiring/award committees
  * are trained to recognize and minimize implicit bias
  * explicitly use multiple dimensions to evaluate candidates’ qualifications (e.g. # publications, research impact, teaching accomplishments, funding potential)
  * have women interviewees meet women faculty
* departments and professional societies offer professional development opportunities for women at all levels
Family Responsibilities


Mason, Stacy, and Goulden, 2004; Data from NSF Survey of Doctorate Recipients 1981-1995
Leaks in the Pipeline: PhD to Tenure Track Position

For each year after the PhD, Married Men with Children under 6 are 50% more likely to enter a tenure track position than are Married Women with Children under 6.

Mason, Stacy, and Goulden, 2004; Data from NSF Survey of Doctorate Recipients 1981-1995
Leaks in the Pipeline: Tenure Track to Tenure

Mason, Stacy, and Goulden, 2004; Data from NSF Survey of Doctorate Recipients 1981-1995

For each year after securing a tenure track position, Men are 20% more likely to achieve tenure than are Women

Mason, Stacy, and Goulden, 2004; Data from NSF Survey of Doctorate Recipients 1981-1995
Everybody is Very Busy

Mason, Stacy, and Goulden, 2004; Data on UC faculty, ages 30-50
solutions include:

✴ employers provide parental leave, tenure-clock adjustment, modified duties for parental or elder care and ensure these will not impact evaluation for promotion or tenure

✴ employers ensure policies are clear, well-advertised, and framed as entitlements, not exceptions [to minimize “bias avoidance” behavior]

✴ department heads and mentors openly offer support and advice on work-life balance to all new faculty, so this is seen as a normal aspect of professional life

✴ departments schedule all meetings during business hours

✴ departments and professional societies offer childcare grants for faculty attending conferences
Dual-Career Couples

• a pervasive issue in physics

(Dual-Science-Couple Survey, McNeil & Sher, 1998; 1990 APS Survey)
  - 68% (18%) of married physicists have scientist spouses
  - 31% (6%) of all physicists < 31yrs have scientist spouses
  - In 85% of couples, man is older [thus, more senior in job]
  - Dual-science-couples seeking first faculty jobs reported
    • short-term career goals affected by these issues (86%)
    • one partner (usually woman) was under-employed (60%)

• solutions include:
  ✴ Employers offer clear, well-advertised spousal hire policies
  ✴ Employers reframe dual-career assistance as recruitment tool
  ✴ Employers form Higher-Education Recruitment Consortia
  ✴ Job candidates raise dual-career issues with employers
Negotiation

Women Don’t Ask: Negotiation and the Gender Divide (Linda Babcock & Sarah Laschever, 2003)

• Women avoid negotiation because they are
  - unsure what they “deserve”; fear asking too much
  - worried about harm to relationships
  - less optimistic about benefits of negotiation
  - not confident of their negotiation skills
  - relatively risk-averse

• In negotiations, women tend to
  ❖ ask for less -- and therefore receive less
  ❖ use “interest-based” negotiation approach, focused on underlying needs/motives rather than narrow concrete goals
  (Getting to Yes: Negotiating Agreement Without Giving In, Roger Fisher & William Ury, 1990)
• **Solutions include**

  ✴ Professional organizations offer workshops on negotiation skills e.g. APS Professional Skills Development Workshops offered annually at major physics meetings (sponsored by NSF); has impacted > 250 women physicists since 2005 [http://www.aps.org/programs/women/workshops/skills/](http://www.aps.org/programs/women/workshops/skills/)

  ✴ Mentors teach women (and men) that interest-based negotiation is very effective and improves professional relationships

  ✴ Mentors recommend targeted readings such as *Ask For It* (Babcock & Laschever, 2009) and *Getting to Yes* (Fisher & Ury, 1990)

  ✴ Employers offer clear directions to job finalists to avoid unintended bias in discussions of salary and start-up packages
Toward large-scale solutions: the NSF “ADVANCE” Program

Increasing the representation and advancement of women in STEM (science, technology, engineering, mathematics) by

• helping universities and professional societies address aspects of academic culture and institutional structure & practice that pose differential barriers to women
• supporting research on effective practices
• creating a community of researchers and practitioners

Since 2001, over $130M has been invested in grants to 100+ universities and organizations across the country.
MSU’s ADVANCE project focuses on ensuring that clear, consistent policies are formulated and followed in faculty

- Recruitment and Hiring
- Annual Evaluation
- Promotion and Tenure
- Leadership Development
- Mentoring

**Solutions include**

- Establishing and communicating clear, consistent, objective evaluation criteria for faculty
- Training administrators
- Standardized electronic faculty records
- Resources & guides for administrators and faculty
- Assistance for units to develop mentoring programs, adopt inclusive search practices, etc.
Conclusions
• **The Leaky Pipeline:**

  Women’s participation rate in physics continues to be low compared to that of men. The scope of the problem is larger than in many other science fields.

  Social Science research reveals numerous causes: family responsibilities, dual-career issues, implicit bias, negotiation skills, isolation...

• **Research also identifies solutions** involving individuals, institutions, and funding agencies

  Clear, known, consistent, family-friendly practices
  Open discussion of the importance of inclusion
  Role models, skill-building and mentoring
What can you do?
What can you do?

EDUCATE YOURSELF
What can you do?

EDUCATE YOURSELF

ACT LIKE A LEADER
Original Score

Do The Right Thing

Music composed and conducted by Bill Lee
Featuring Branford Marsalis