

## Topic 2: Launching A Successful Physics Career

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**Abstract.** The facts that there are few women in physics and their presence decreases at each higher level in the hierarchy are evidence that women physicists face challenges in launching and pursuing a successful physics career. In four parallel discussion groups led and recorded by the coauthors, about 80 of the conference participants discussed the issues involved, shared proven solutions, and brainstormed other possible strategies. This paper summarizes the results of the discussions, emphasizing useful advice for aspiring women physicists and those interested in facilitating their retention and advancement.

### ISSUES

#### Background

Physics knowledge and skills are assets for careers in academia, industry, government, finance, writing, and even medicine. In these various arenas, physicists perform research, teaching, management, or service. Some careers require education to the doctorate level, while others require only bachelor's or master's degrees. In many countries, one must have a doctorate in physics to be considered a physicist; thus, most conference attendees either had physics doctorates or were currently enrolled in a doctoral program. Whereas women comprise a minority of physics Ph.D. recipients in all countries, ranging from a few percent to nearly 30%, 10 years after the degree, the proportion of women in the physics workforce in every country is substantially lower. Each attendee knows talented colleagues—both men and women—who gave up physics. But the fraction of women who have done so is much larger than the fraction of men.

#### Defining Success

To the discussion participants, success centered on being able to make their best contributions to physics in a subfield and career path of their interest and choosing. Beyond this essential element, success had three major dimensions: earning *recognition* within the physics community, making an *impact* on society, and achieving *personal goals*. *Recognition* involves advancement within the hierarchy, the respect of peers and students, speaking invitations, job offers, awards, funding, and salary. *Impact* relates to improving the world, one's country, or the profession of physics. *Personal* success factors could involve independence, fun, life balance, or rewards commensurate with effort. Individuals place different importance on the three dimensions; moreover, typically the relative prominence of each dimension changes during a person's career.

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## **Career Phases and Issues**

During and immediately after graduate school, the focus is on choosing a physics specialty and career path (e.g., research, teaching, industry, government). It is important for students and recent doctorates to think about and set near-term and long-range goals, and simultaneously to be flexible and alert to exciting but unanticipated opportunities that might arise. Key challenges for those pursuing a research career, for example, are to obtain funding and a position and to earn high marks from peer reviewers assessing research proposals. Often, during the early-career phase the demands of family responsibilities (marriage, infants, and young children) are particularly strong and divert women physicists from the single-minded career focus expected by employers. Many of the successful senior women physicists at the conference managed to raise children. It is important that women, men, and employers realize that women can have both a physics career and a family (in most countries).

To succeed professionally, one's reputation and visibility must grow. Both in graduate school and in the workplace, good supervisors or mentors can be very helpful. Women whose professors and first employers actively championed their physics potential and performance gained valuable self-confidence. Those who were given important assignments advanced comparatively rapidly. Doing a great job on a minor or invisible assignment is clearly better than doing a miserable job in it—but it does not help one's career as much as success in an important and visible assignment. Opportunities to lead even a small subproject typically provide a better career boost than always being a follower. Discussants suggested that women participating in enormous collaborations (such as those common in experimental high-energy physics) need to ensure they are not limited to support roles and contributions.

A woman who seeks promotions, professional recognition, and rewards must understand the "rules of the game," and deliberately acquire the skills and experience needed to enter the next higher level. These "rules" are the collection of practices, behaviors, and expectations—often unwritten—that determine who gets hired or promoted. In most countries, the rules of the game in physics are not particularly clear, and they produce barriers that few women physicists have surmounted. In some cases, for example, the "rules" seem to favor highly competitive behavior, called "combat physics" by conference participants, that discourages and even offends many women.

Participants have mixed feelings about the value of affirmative action regulations. In some instances these requirements are necessary to overcome clear barriers to women. In other cases they involve inflexible procedures and carry a reverse-discrimination stigma, which perversely makes it even harder for women to advance.

## **IMPORTANT INTERNATIONAL DIFFERENCES**

The 65 countries represented at the conference have a broad range of social/cultural expectations of women and women's roles in society. In some cultures the education of women is not a high priority. In others, family responsibilities make it nearly impossible for women to pursue any career, much less one as demanding as physics.

The size of a country and its physics enterprise proves to be an important difference during the early career. In countries with a small physics community, it is essential for aspiring physicists to spend several years abroad. This experience helps the physicist develop the professional contacts, collaborators, credentials, and professional reputation needed to be selected for a permanent position in the home country.

The affluence of a country determines whether it has funding opportunities or an infrastructure for physics research. In poorer countries, experimental specialties are simply not viable because the necessary apparatus is unavailable and unaffordable.

Perhaps the most important differences are between developed and developing countries. Developing countries usually have less advanced schools and have few, if any, universities. If there is a university, it is not among the best in the world, thereby disadvantaging those educated there. Developing countries typically have no research opportunities. If there is significant industry, it usually exploits low-wage manual labor, rather than offering high-tech, intellectually challenging jobs.

## **SUCCESSFUL SOLUTIONS**

Successful women physicists in every country are extraordinarily talented and very passionate about physics. These women have had to take a lot of initiative, to seek out people—especially leading physicists—for advice, to ask for what they need or want, to promise a lot and accomplish more, and to overcome adversity of many types. Self-confidence is essential: when families, teachers, advisors, and colleagues give girls and women strong encouragement and praise their accomplishments and contributions to physics, self-confidence rises. Many

successful women research physicists have chosen to be pioneers in a comparatively new subfield, where perspectives and approaches have not yet become as rigid as they are in established specialties. At institutions where men and women in leadership positions have noticed and remedied inequities and “leveled the playing field,” women physicists are growing in number and prominence.

## RECOMMENDATIONS

The following recommendations emerged in the discussions about launching a successful career. Several are based on strategies that have proven successful in one or more countries. Others are promising ideas developed by conference participants. Most have been incorporated in the Conference Resolutions and Recommendations. Not all will be applicable or useful in every country or situation.

- Create, support, and encourage networks for women physicists—local, national, and international, including a worldwide e-network—to provide career support, advice, role models, and information about job opportunities and funding sources. Networks are proven means to help women physicists help each other and overcome the marginalization that often occurs when they are the lone woman in a group.
- Have transparent, gender-blind processes for important decision making. To improve accountability, require that important decisions be reported and explained. Important decisions include those related to recruiting, promotion, salaries, funding, and the allocation of space and equipment.
- Place women on important committees and policy-making bodies to improve the system, change the “rules,” and give the women opportunities to have visible impact.
- Provide early and frequent opportunities for women to participate in physics research, author or co-author papers, attend conferences, and give physics talks.
- Provide enlightened and supportive supervisors and mentors for women physicists at every career stage. These people should treat the women in a respectful and collegial manner, obtain funding, teach the women the “rules of the game” and how to write successful proposals, introduce them to important professional contacts, give them challenging assignments and opportunities, provide constructive feedback on unsuccessful proposals or interviews, give them credit, send them to conferences, and advocate them in the physics community.
- Provide training for women physicists in presentation of results, paper writing, job applications, grant writing, the “rules of the game,” assertiveness, etc.
- Shorten the post-post-doc phase with its insecurity, relocation requirements, and tendency to create a “two-body” problem for couples that form during this period.
- Establish a speaker program for women physicists. Maintain a web list of speakers and topics, and provide a funding source(s) to support the costs of speaker travel.
- Organize prestigious, topical international physics summer schools with significant participation and leadership from women physicists and convenient child care.
- Ensure that national and international sources of funding for scientific research give women an equitable opportunity for awards.
- Accord a career interruption for “family service” the same respect as military service gets in most countries. Pause the career clock, have flexible age limits for grants and fellowships, and provide resources to help women restart their careers after a break.
- Help dual-career couples find two appropriate positions in close proximity.
- Collect and publish data internationally on physics demographics, including gender, to watch and influence trends in the participation and advancement of women. Also collect data on why women leave physics.

## SUMMARY

Women have insights, ideas, and much energy to contribute to physics. Yet in essentially all countries many talented women are lost from the physics profession between graduate school and a position of leadership. If implemented, the ideas and recommendations developed at the conference and particularly in the discussions on “Launching a Successful Physics Career” should help increase the retention, visibility, and advancement of women in physics.