REPORT ON THE FIRST INTERNATIONAL CONFERENCE ON WOMEN IN PHYSICS

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PARTICIPATION OF WOMEN IN PHYSICS

Why are there so few women in physics? In Canada and globally, the number of women in physics is small. Increasing female participation in physics is an opportunity for physics worldwide, not just as a fairness issue, but due to a great need for talent in physics. It has been documented that performance in high school and undergraduate physics is not gender-dependent, and that intelligence is not correlated with gender. The talent pool from which new ideas and major breakthroughs are made would greatly increase if female participation in physics matched that of men: approximately half the human brainpower on earth is in the heads of women. Taxpayers support a large portion of physics and scientific research, so it is only fair and reasonable to encourage men and women to benefit equally and to derive equal opportunities from these public research funds. A more scientifically literate public, which includes women and girls who have studied physics, will likely lead to more public support of science.

The talent pool from which new ideas and major breakthroughs are made would greatly increase if female participation in physics matched that of men.

In many countries, including Canada, a large number of retirements resulting from the hiring boom of the sixties and seventies has resulted in many physics career opportunities opening up in industry, government laboratories and universities now and in the next few years. We must thus address the dearth of women in physics in a timely manner before this next wave of hiring is complete. Excluding and discouraging women from studying physics does not serve physics, science nor society in general.

INTERNATIONAL CONFERENCE ON WOMEN IN PHYSICS

The First International Conference on Women in Physics was held in Paris, March 7-9, 2002. Among the goals of the conference were to understand the severe under-representation of women in physics and to develop strategies to increase their participation in physics. The conference took place at the UNESCO headquarters in Paris, organized by the International Union of Pure and Applied Physics (IUPAP). Over 300 physicists from 65 countries participated in the conference.

Representatives from each country presented posters summarizing the situation in their home countries, and each country's team submitted a short contribution for the proceedings. The conference included eleven plenary presentations in which speakers from Africa, North and South America, Europe and Asia detailed the situation and issues for women in physics, as seen from the perspective of their own countries, presenting anecdotes as well as statistics.

Six discussion groups were formed to address specific topics:

1. Attracting girls into physics
2. Launching a successful physics career
3. Getting women into the physics leadership structure
4. Improving the institutional climate for women in physics
5. Learning from regional differences
6. Balancing family and career

The discussions led to a set of resolutions (Appendix I) ratified at the conference, and a set of recommendations (Appendix II) for delegations to bring home and implement (when applicable) in their respective countries.

There were many interesting presentations and discussions at the conference, and a selection of highlights follows. Further information, including plenary talks, summaries of discussion groups and contributions from the delegations may be found in the conference proceedings [1].

A delegation of physicists from Canada participated in this conference (Figure 1) and presented a poster [2] on the challenges of attracting and retaining women in physics in Canada (Figure 2) and a short summary of the status of women in physics in Canada.

PRE-CONFERENCE SURVEY

Shortly before the conference, an international survey of women physicists was conducted by the Working Group on Women in Physics of the IUPAP, and the data were analysed and published by the Statistical Research Center of the American Institute of Physics [3] and presented at the conference. The survey addressed issues related to education, from secondary school level to the highest earned degree, and employment. The impact of marriage and chil-

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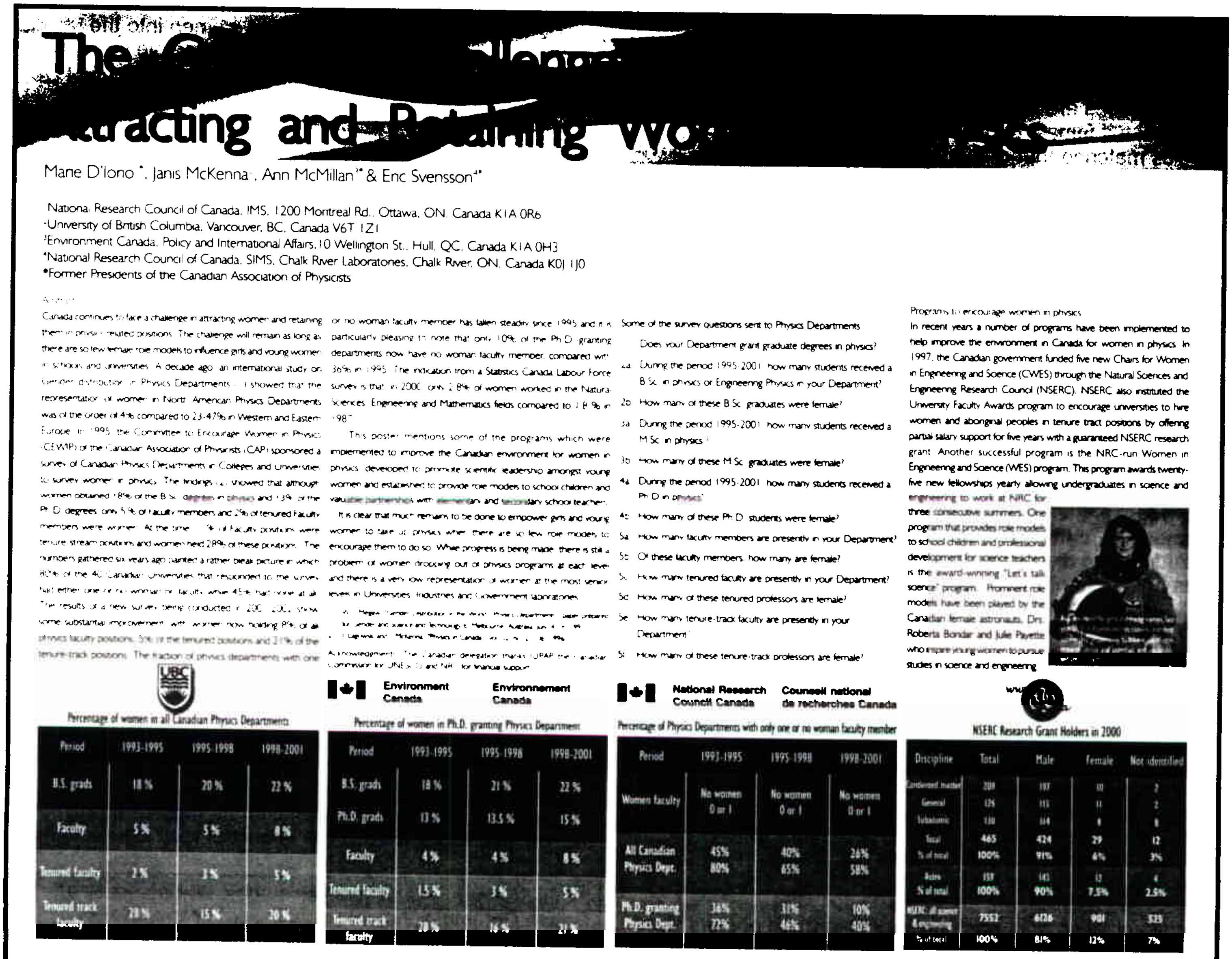
dren, factors which contributed to the success women had achieved, and suggestions for what could be done to improve the situation for women in physics were addressed in the questionnaire. Over 1000 responses were received from women physicists in 55 countries. Over two-thirds of the respondents had PhD degrees.

Fig. 1 The Canadian delegation to the International Conference on Women in Physics: Marie D'Iorio, Janis McKenna, Eric Svensson, and Ann McMillan.

About a third of the women felt that they had progressed more slowly in their careers than their colleagues. Disheartening was the revelation that a significant number of women felt that the demands of a career in physics seemed to preclude them from marrying and/or having children. Of the married respondents, a large number reported that marriage affected their work, and similar responses were noted on the question of children.

Most respondents developed an interest in physics before or during secondary school education, and most had positive experiences as undergraduates and graduate students.



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Abstract

Canada continues to face a challenge in attracting women and retaining them in physics related positions. The challenge will remain as long as there are so few female role models to influence girls and young women in schools and universities. A decade ago, an international study on Gender distribution in Physics Departments (1) showed that the representation of women in North American Physics Departments was of the order of 4% compared to 23-47% in Western and Eastern Europe. In 1995, the Committee to Encourage Women in Physics (CEWIP) of the Canadian Association of Physicists (CAP) sponsored a survey of Canadian Physics Departments in Colleges and Universities to survey women in physics. The findings (2) showed that although women obtained 18% of the B.Sc. degrees in physics and 13% of the Ph.D. degrees, only 5% of faculty members and 2% of tenured faculty members were women. At the time, [illegible]% of faculty positions were tenure-stream positions and women held 28% of these positions. The numbers gathered six years ago painted a rather bleak picture in which 80% of the 40 Canadian Universities that responded to the survey had either one or no woman on faculty, while 45% had none at all. The results of a new survey being conducted in 2001-2002 show some substantial improvement, with women now holding 8% of all physics faculty positions, 5% of the tenured positions and 21% of the tenure-track positions. The fraction of physics departments with one or no woman faculty member has fallen steadily since 1995 and it is particularly pleasing to note that only 10% of the Ph.D.-granting departments now have no woman faculty member, compared with 36% in 1995. The indication from a Statistics Canada Labour Force survey is that in 2000, only 2.8% of women worked in the Natural Sciences, Engineering and Mathematics fields compared to 1.8% in 1987.

This poster mentions some of the programs which were implemented to improve the Canadian environment for women in physics, developed to promote scientific leadership amongst young women and established to provide role models to school children and valuable partnerships with elementary and secondary school teachers.

It is clear that much remains to be done to empower girls and young women to take up physics when there are so few role models to encourage them to do so. While progress is being made, there is still a problem of women dropping out of physics programs at each level and there is a very low representation of women at the most senior levels in Universities, Industries and Government laboratories.

(1) Megaw, Gender distribution in the world's physics departments, paper prepared for Gender and Science and Technology 6, Melbourne, Australia, [illegible]
(2) [illegible] and McKenna, Physics in Canada, [illegible] 1996

Acknowledgement: The Canadian delegation thanks IUPAP, the Canadian Commission for UNESCO and NRC for financial support.

Some of the survey questions sent to Physics Departments

Does your Department grant graduate degrees in physics?
2a During the period 1995-2001, how many students received a B.Sc. in physics or Engineering Physics in your Department?
2b How many of these B.Sc. graduates were female?
3a During the period 1995-2001, how many students received a M.Sc. in physics?
3b How many of these M.Sc. graduates were female?
4a During the period 1995-2001, how many students received a Ph.D. in physics?
4b How many of these Ph.D. students were female?
5a How many faculty members are presently in your Department?
5b Of these faculty members, how many are female?
5c How many tenured faculty are presently in your Department?
5d How many of these tenured professors are female?
5e How many tenure-track faculty are presently in your Department?
5f How many of these tenure-track professors are female?

Programs to encourage women in physics

In recent years a number of programs have been implemented to help improve the environment in Canada for women in physics. In 1997, the Canadian government funded five new Chairs for Women in Engineering and Science (CWES) through the Natural Sciences and Engineering Research Council (NSERC). NSERC also instituted the University Faculty Awards program to encourage universities to hire women and aboriginal peoples in tenure tract positions by offering partial salary support for five years with a guaranteed NSERC research grant. Another successful program is the NRC-run Women in Engineering and Science (WES) program. This program awards twenty-five new fellowships yearly allowing undergraduates in science and engineering to work at NRC for three consecutive summers. One program that provides role models to school children and professional development for science teachers is the award-winning "Let's talk science" program. Prominent role models have been played by the Canadian female astronauts, Drs. Roberta Bondar and Julie Payette who inspire young women to pursue studies in science and engineering.

UBC

Percentage of women in all Canadian Physics Departments

Period	1993-1995	1995-1998	1998-2001
B.S. grads	18 %	20 %	22 %
Faculty	5 %	5 %	8 %
Tenured faculty	2 %	3 %	5 %
Tenured track faculty	28 %	15 %	20 %

Environment Canada / Environnement Canada

Percentage of women in Ph.D. granting Physics Department

Period	1993-1995	1995-1998	1998-2001
B.S. grads	18 %	21 %	22 %
Ph.D. grads	13 %	13.5 %	15 %
Faculty	4 %	4 %	8 %
Tenured faculty	1.5 %	3 %	5 %
Tenured track faculty	28 %	16 %	21 %

National Research Council Canada / Conseil national de recherches Canada

Percentage of Physics Departments with only one or no woman faculty member

Period	1993-1995	1995-1998	1998-2001
Women faculty	No women 0 or 1	No women 0 or 1	No women 0 or 1
All Canadian Physics Dept.	45% 80%	40% 65%	26% 58%
Ph.D. granting Physics Dept.	36% 72%	31% 46%	10% 40%

NSERC Research Grant Holders in 2000

Discipline	Total	Male	Female	Not identified
Condensed matter	209	197	10	2
General	125	111	11	2
Subatomic	130	114	8	8
Total	465	424	29	12
% of total	100%	91%	6%	3%
Astro	157	141	12	4
% of total	100%	90%	7.5%	2.5%
NSERC all science & engineering	7552	6126	901	525
% of total	100%	81%	12%	7%

Fig. 2 Canadian Poster presented at IUPAP Conference (see http://www.physics.ubc.ca/~janis/iupap-poster.pdf)

Interestingly enough, while it was clearly difficult to balance family and career, this was not a critical issue: women without children consider themselves no more successful than those with children. Additionally, there was no notable increase in the success or representation of women in Canada and the Scandinavian countries, which have legislated family-friendly policies, including maternity/paternity leave, and reasonable availability of childcare facilities.

Factors frequently cited as contributing to the success of women physicists were support of families (parents and/or husbands), advisors, teachers and colleagues. Around the world, barriers faced by the women surveyed included balancing family and career and discriminatory attitudes. In developing countries in particular, family responsibilities often included aging parents, in addition to children. Globally, women in senior appointments, such as directors of research institutions and senior positions in industry and universities are at the few percent level, when they exist at all. There is a large variation in data from different countries, but the leaky pipeline phenomenon, in which the number of women in physics decreases dramatically with advancing career level, was found to exist world-wide, and the leakage has not diminished for young women physicists, despite being recognized already a generation ago. Three-quarters of respondents felt that the situation for women physicists in their own countries needed improvement. On a positive note, three-quarters of the women responded that if they had the chance, they would choose physics as a career again. It was noted that women who left physics did not respond, and information from these women could be very relevant to many of the issues studied. Some very interesting anecdotal information was also presented.

THE SITUATION IN CANADA

In 1995, CAP's CEWIP (Committee to Encourage Women in Physics) sponsored a survey[4] of Canadian college and university physics departments. The findings revealed that between 1993-1995, 18% of BSc's and 13% of PhD's in physics were granted to women and only 5% of faculty and 2% of tenured faculty in physics were women. By 1998-2001 the situation had improved slightly: 22% of BSc's and 15% of PhD's were granted to women, and 8% of faculty and 5% of tenured faculty in physics were women. Statistics are on the IUPAP poster in Figure 2. Although we have a number of programs in Canada which have been implemented to improve the Canadian environment for women in physics, the number of women in physics in Canada has remained discouragingly small. These programs include:

1. ***National Parental Leave***: Canada has a legislated national parental leave program for maternity or paternity leave which pays part of one parents' salary during parental leave after the birth or adoption of a child.
2. ***Affirmative Action Programs***: The goal of NSERC's University Faculty Awards program is to decrease the under-representation of women and aboriginal peoples in faculty positions in sciences and engineering, by providing partial salary support for five years in a tenure-track position.
3. ***Awareness Programs***: The CWES (Chairs for Women in Engineering and Science) program has five regional professorial chairs which are mandated to develop strategies to encourage female students in elementary and secondary schools to consider scientific/technical careers. The WES (Women in Engineering and Science) program provides twenty-five new fellowships to enable the very top first year undergraduate women an opportunity to work in NRC's laboratories for 3 consecutive summers, with a mentor. The award winning "Let's Talk Science" program matches graduate student volunteers in science with elementary and high school teachers in partnerships in which young students interact and learn with budding young scientists in their graduate school years.

RESOLUTIONS AND RECOMMENDATIONS

The resolutions of the conference (Appendix I) are aimed to bring more women into mainstream and leadership positions in physics, and are directed to schools, governments, universities, faculty, scientific societies, national governments, granting agencies and the IUPAP.

The recommendations of the conference (Appendix II) focused on attracting girls into physics, launching a successful physics career, balancing family and career and getting women into positions of leadership.

OTHER HIGHLIGHTS AND SURPRISES AT THE CONFERENCE

Many issues and studies were publicized and discussed at the conference. Three interesting studies are discussed here.

1. A study at MIT[5] publicized in 1999, revealed that female faculty in science had less lab space, lower salaries, smaller start-ups, fewer research resources, more committee work, more teaching assignments, fewer professorial chairs and more obligations than their male counterparts at similar career stages. Additionally a pattern of gender discrimination in hiring, promotion and awards was uncovered. Young faculty members, both men and women, felt well supported, satisfied and very optimistic about their careers. But a surprising finding of this study was that each generation of young women, including those who are currently senior faculty, began their careers believing that gender discrimination had been eliminated, but later felt marginalized and excluded from significant roles in their departments and positions of real power as they progressed through their careers (i.e. young boys become part of the "old boys" network, while young women become marginalized "old gals"). Also, at MIT in the decade preceding the report, the fraction of women on faculty had not increased at all, despite perceptions that improvements in the situation for women had taken place. Several subsequent studies at American universities (Caltech[6], U Michigan[7], U Wisconsin[8], U Illinois Urbana-Champaign[9], and U Pennsylvania[10]) have shown that this situation is not particular to MIT. In response to the MIT report, many new policies and

actions were implemented, and the number of women faculty at MIT has risen by approximately 40% in the past three years!

We strongly encourage Canadian institutions to perform similar studies of women in sciences, or women in sciences/engineering (unfortunately the statistics are too low to study physics alone) and propose actions to address any uncovered inequities.

2. An analysis of peer-review scores for postdoctoral fellowship applications in Sweden published in 1997 revealed startling and blatant evidence that the peer-review system was riddled with prejudice, sexism and nepotism [11]. The study revealed that women had to be two and a half times more productive than men (as measured by citations, publications and a collection of similar measures) to rate the same scientific competence scores by referees adjudicating national fellowship awards. It also revealed that, in addition to gender of the applicant, connections to any of the referees (i.e. nepotism) increased scientific competence scores for both men and women. Several other countries have since performed similar analyses and some of the preliminary findings were discussed at the conference. In Britain, no significant bias in peer-review was found, but it was noted that women simply do not apply for grants in the numbers expected, based on academic employment and eligibility figures [12]. The discrepancy between the number of women who apply for grants and the number of eligible women is huge - greater than a factor of two.

3. A 2000 report from ETAN (European Technology Assessment Network) [13] gathered statistics on women in science and technology all across the European Union. A key problem noted was the dearth of women in senior scientific positions, even despite different cultures and research systems in the EU countries. The extensive report concluded that the data provide a shocking snapshot of exclusion and segregation, and found that the under-representation of women in science and technology threatens the goals of science in achieving excellence, as well as being wasteful and unjust. The report urges the pursuit of gender-neutral science.

These three high-impact studies helped lift the issues of discrimination against women from a few anecdotes to well documented widespread and statistically significant findings. Many other issues were raised at the conference (and in the above cited reports) including:

1. We should challenge and change the stereotype of a tousle-haired white male physicist "nerd" by promoting role models and mentors for young girls, to assure them that they indeed may pursue successful careers in science. [17]
2. Acknowledge the dual-career or trailing spouse problem (most women physicists are married to other physicists or scientists)
3. The long apprentice periods in physics in many countries (eg. postdoctoral and term appointment positions before permanent employment) was seen as discouraging to women in physics.
4. Balancing a physics career with a family is challenging.
5. In many cases, inequities were subtle, apparently unintentional and only became convincing due to the large scale of the studies undertaken. [5,11]
6. "Cronyism", the abuse of the "old boys'" network, was found to be prevalent in many of our scientific institutions [7,14].
7. Sexual harassment, bullying, and lobbying by senior men against women, while not widespread, was nevertheless reported with disturbing frequency [7,13,15,16].

A frustration often cited by women worldwide was that there were challenges in their own institutions when it came to encouraging colleagues to consider hiring more women: colleagues would sometimes suggest that hiring a woman and hiring an excellent candidate were mutually exclusive concepts.

Another point of discussion at the conference was why physics had such a vast under-representation of women, while many equally demanding and challenging careers, such as medicine and law, apparently do not suffer a lack of women in the same manner. (There is evidence that although the fraction of women in these fields is large, there remains a "glass-ceiling" effect - women tend not to be equally represented at the most senior levels within these professions). The "chilly climate" for women in physics and the "leaky pipeline" phenomena may not be as prevalent in other demanding careers. If not, we should try to understand why. Further studies are needed to help understand the situation. We can work hard to encourage more women to enter physics, but this will not help much if women continue to leave the pipeline at each major career step.

SUMMARY

In summary, the conference provided much eye-opening information and stirred a sense of hope and excitement for the future of physics. Many of the recommendations and resolutions would serve to improve the working environment for both men and women in physics. It was also noted that understanding the problems faced by women in physics will likely provide insight into the issue of under representation of women in other professions. There are those who argue that it really doesn't matter that there are so few women in physics and we agree with a reflection from our British colleagues:

"There is ample data that intelligence is distributed equally between the sexes. Girls are performing well in all school and university examinations. If it is important to have the most able scientists in the best-equipped laboratories to maintain the science and technology base, then it makes sense to choose them from the whole population, rather than just the male half. In so far as women are different, they bring important team working skills to the science environment." [15]

We note that the report of the US delegation [18] to the conference was just released as we were finalizing our report,

and it includes an analysis of critical factors leading to low representation of women in physics.

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APPENDIX I

Conference Resolutions

1. *Introduction*

Physics plays a key role in understanding the world we live in, and physicists contribute strongly to the welfare and economic development of nations. The knowledge and problem-solving skills of physicists are essential in many professions and industries and to society at large. To thrive in today's fast-changing, technological world, every country must achieve a highly educated population of women and men, fully engaged in making decisions important to their well being.

Thus, knowledge of physics is an important part of general literacy for every citizen. In addition, advancing physics understanding is an exciting intellectual challenge that benefits from the diverse and complementary approaches taken by both women and men from many cultures. Currently women can and do contribute to this quest and, through physics, to the welfare of humankind, but only in small numbers: women are an underutilized "intellectual reserve." Only when women participate fully as researchers in the laboratory, as scientific leaders and teachers, and as policy makers will they feel equal partners in a technological society.

The ideas in these resolutions are aimed at bringing more women into the mainstream and leadership of physics. They were unanimously approved by over 300 physicists from 65 countries attending the first International Conference on Women in Physics, held in Paris, France, 7-9 March 2002.

Each country is different. Thus the conference participants are translating these resolutions into their own language. In the translation, the ideas in the resolutions will be appropriately phrased and directed to the responsible entities in each country.

1. *Resolution Directed at Schools and Their Government Sponsors*

Girls should be given the same opportunities and encouragement as boys to learn physics in schools. When parents and teachers encourage girls, it strengthens their self-confidence and helps them advance. Methods and textbooks used in teaching physics should include those that have been shown to interest girls in physics and foster their success. Studies show that young girls have a strong desire to help improve people's lives, and therefore it is important that they have the opportunity to see ways that physics has a positive impact on society.

2. *Resolutions Directed at Universities*

2.1 Students

Universities should examine their policies and procedures to ensure that female students are given an opportunity for success that equals that of male students. All policies that perpetuate discrimination should be abolished, and policies that promote inclusion should be adopted. This may involve adopting such practices as: using a broad interdisciplinary approach to physics; providing flexible entry criteria to the physics major; allowing early participation in research; providing mentoring; and exposing students to the important contributions physics makes to other sciences, medicine, industry and the quality of daily life. Adopting these practices will have an especially positive effect on young women, who often feel isolated and unwelcome in physics.

2.2 Faculty and Researchers

Recent studies have shown that, even at top research institutions, women scientists have not been treated fairly with respect to their male colleagues. This is not only very harmful to women in science but in the long run will be harmful to science as well. Universities must examine and communicate their policies and practices to make sure that they promote equity; it is of key importance that universities guarantee transparent and fair

mechanisms of recruitment and promotion. Additional important elements for success are access to research funding and facilities and sufficient time for research.
Having a family should not be allowed to impede a woman's participation in a scientific career. A family-friendly environment that provides such things as child-care facilities, flexible working schedules and employment opportunities for dual career families will enable career success.

University governance has been found to be dominated by men. Women need to be included in university and physics department governance, particularly on key policy committees. Women must have input into those policies that control their own destinies. It is important for the development of young women physicists to see successful women active in research, teaching and leadership.

3. *Resolution Directed at Research Institutes*

Research institutes will benefit from policies that allow women scientists to be successful. Institute directors should make sure that policies that promote gender equity in recruitment and promotion are adopted and enforced. Too often what has been termed a "glass ceiling" is allowed to stop the advance of women's careers.

Institute directors should take an active part in ensuring that family-friendly practices such as child-care facilities and flexible working schedules are available to all. Surveys repeatedly show that a leading concern of women is balancing career and family life; having a family should not be allowed to impede successful participation in scientific research.

4. *Resolution Directed at Industries*

Industries will benefit from policies that allow women scientists to be successful. Industrial managers and research directors should make sure that policies that promote gender equity in recruitment and promotion are adopted and enforced. Too often what has been termed a "glass ceiling" is allowed to stop the advance of women's careers.

Industrial managers should take an active part in ensuring that family-friendly practices such as child-care facilities and flexible working schedules are available to all. Surveys repeatedly show that a leading concern for women is balancing career and family life; having a family should not be allowed to impede successful participation in scientific research.

5. *Resolution Directed at Scientific Societies*

Scientific and professional societies can and should play a major role in increasing the number and success of women in physics. Each society should have a committee or working group that is responsible for such issues and that makes recommendations to the society as a whole. At a minimum societies should do the following things: work with other organizations to collect and make available statistical data on the participation of women in physics at all levels; identify women physicists and publicize them as role models; include women on program committees and as invited speakers for society-sponsored meetings and conferences; and include women on editorial boards of society journals.

6. *Resolution Directed at National Governments*

Physics plays a key role in understanding the world we live in, and physicists contribute strongly to the economic and cultural development and welfare of nations. It is therefore in every nation's self-interest to provide strong physics education for all its citizens and to support advanced education and research. Governments must ensure that women have the same access and chance for success in research and education as men. National planning and review committees should include women, and awards of government funds should only be made to organizations and institutions that make gender equity a part of their policies.

7. *Resolution Directed at Granting Agencies*

Agencies that make funding available for scientific research play a key role in promoting the success of individual scientists as well as science as a whole. Past studies have shown evidence for gender bias in the review process. Therefore, to ensure that women have the same access to research funding as men, all competitions for funding should be transparent and widely publicized; the criteria for obtaining funds should be clear; and women should be included on all review and decision making committees. Limits on age of eligibility or grant structure and duration that seriously disadvantage applicants taking family leave should be reconsidered. Granting agencies should maintain and make available statistical data by gender, including such information as the proportion and qualifications of women and men who apply for funding and who obtain funding.

8. *Resolution Directed at IUPAP*

IUPAP is the international organization of physicists and as such exerts considerable influence on the physics community through its statements and activities. IUPAP should both endorse the above resolutions aimed at other groups and also examine its own actions to make sure that they contribute to increasing the number and success of women in physics. It will also be valuable for IUPAP to communicate the results of this conference to international scientific organizations in other fields. In the election of IUPAP's Executive Council and Commission members, procedures should be instituted to ensure the full inclusion of women. IUPAP sponsors major international conferences; a criterion for such sponsorship should be the demonstration that women are included on the International Advisory Committees and Program Committees. IUPAP should require conference organizers to report gender distribution of invited speakers. IUPAP should encourage all of its national Liaison committees to include women among their members. Liaison committees should also advocate these resolutions in their countries. IUPAP should continue its Working Group on Women Physics and empower it to establish an international advisory committee with a member in as many countries as possible. Finally, this group will form the basis of a network that can continue the work of increasing the number and success of women in physics.

APPENDIX II

Recommendations from The IUPAP International Conference on Women in Physics

Maison de l'UNESCO, Paris, France
7-9 March 2002

Many specific recommendations emerged during the conference. Not all will be applicable to all countries or situations. They should be reviewed by each country's team, which should translate the applicable ones and work to implement them in their country. The recommendations are grouped into cate-

gories, but many are likely to have impact in other categories, too. Note that most of these recommendations, when implemented, will improve physics for both men and women.

General Recommendations

1. Coordinate data collection and access internationally on physics demographics, including gender, to watch and influence trends. Collect data regularly (every one to three years) and in a consistent way, to watch and influence trends. Request data from national and regional physical societies. Find out also why women leave physics.
2. Create, support, and encourage networks for women physicists: local, national, international, including a world-wide e-network. Create women-in-physics web pages in each country, with links to each other and to information on successful strategies and programs. Provide a well publicized international web presence for Women in Physics.
3. Involve men, especially highly respected physics leaders, in improving the climate for women (and minorities) in physics.
4. Have transparent, gender-blind processes for important decision-making. Transparency can be aided by having a requirement for decisions to be reported and explained. Important decisions include those related to recruitment, selection, salary, promotion, peer review, conference programs, allocation of space and equipment, and other issues affecting important working conditions.
5. Establish mechanisms to assess and improve the climate for women (and minorities) in physics. Proven approaches include creating special committees for women in physics and focusing resources and attention on this issue. Examples include having a source of matching funds for initial years of a tenure-track position filled by a woman, and committees that visit universities, research institutes, and other physics employers to advise on their climate for women.
6. Encourage written rules and policies (for example an equality policy) to achieve fairness and transparency in policies, practices, and decision making.
7. Provide Web 'index' of links to international funding sources.
8. Remove barriers to full participation of girls and women (restrooms, dormitories, etc).
9. Adjust the reward structure at all levels to encourage desired behaviors.

Attracting Girls into Physics (childhood to university)

10. Revise educational curricula and materials to connect physics with medicine, biology, technology, the environment, etc. and to show diverse physics career paths and job prospects. Ensure physics courses, math courses, textbooks, equipment, and funding for girls' education are as good as for boys' education, and feature women physicists as role models.
11. Strengthen the training of science/physics teachers and include opportunities for them to do research and to interact with working scientists. Train teachers and counsellors about gender issues (girl-friendly classroom atmosphere, examples of interest to girls). Attract qualified school teachers with fair pay, respect, and working conditions.
12. Publicize physics role models who counteract the stereotypes and whose stories are examples of career success and leadership positions.
13. Educate parents about opportunities for daughters and how to encourage them.
14. Help smart girls network (clubs, enrichment opportunities, and encouragement).
15. Attract more girls to compete in prestigious physics competitions.
16. Raise boys to share family responsibilities and to expect women to have professions.
17. Get international help and funding for schools in developing countries.
18. Involve universities, research institutes, and industries to help schools and strengthen teacher training.

Launching a Successful Career (University to Mid-Career)

19. Have flexible entry and graduation requirements for physics majors, and provide early opportunities for students to participate in research.
20. Train/sensitize faculty and supervisors to gender issues (female-friendly atmosphere, respectful and collegial treatment).
21. Provide enlightened and supportive mentors and supervisors for women physicists. These people should find 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, and advocate them in the physics community.
22. Provide training for women physicists in presentation of results, paper writing, grant applications, etc.
23. Shorten the post-post-doc phase with its inherent insecurity and relocation requirements.

Balancing Family and Career

24. Respect and value family obligations (quality child care convenient to workplace and at conferences, flexible working hours).
25. Pause 'career clock' and have flexible age limits and rules for grants and fellowships, to not disadvantage people who take time for family responsibilities. (Accord career interruptions for 'family service' the same respect as for 'military service'.)
26. Provide funding sources to help people return to physics after a career pause.
27. Solve the dual-career couple problem by facilitating geographically co-located job opportunities and creative solutions, such as shared positions.

Getting Women into Physics Leadership

28. Appoint women physicists to leadership positions and include them on important committees in their institutions, countries, professional societies, and IUPAP.
29. Involve more people in leadership. Consider innovative approaches, such as shared positions, term appointments, and novel structures.