Women in Physics:

Why so few?

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University of British Columbia

Women In Physics

A conference was organized by the IUPAP in March in Paris.

Goals:

- To understand severe under-representation of women in physics
- develop strategies to increase participation of women in physics

Why Bother Increasing Female Participation?

- Women are an untapped source of talent and innovation: more new ideas and breakthroughs if **more** people doing physics (not just male half of humanity!)
- More scientifically literate public if more people (men & women) trained in science
- Fairness - taxpayers foot bill - shouldn't we all have equal opportunities?

Why especially urgent now?

A large number of retirements is resulting in MANY opportunities for physicists in industry, government and academia NOW.

The Conference

- Over 300 physicists
- ~15% men
- Teams from 65 countries
- Plenary talks from all major regions:
  (Africa, Europe, North & South America, Asia)
- Posters from each country

Discussion Groups

6 Discussion Groups for ideas & brainstorming:

- Launching a successful physics career
- Getting women into physics leadership
- Improving the institutional climate
- Learning from regional differences
- Balancing family and career
- Attracting girls into physics

Pre-conference survey

Survey conducted by IUPAP, analyzed & published by AIP.

Over 1000 responses from women physicists in 55 countries.

2/3 of respondents had PhD degrees. (but biased)

- Interest in physics typically starts early (high school)
- Support of families and teachers/mentors/graduate supervisors frequently cited as contributing to success
- Generally had positive experiences as grad/undergrad students
- *Leaky pipeline* phenomenon exists around the world
- challenges in balancing family and career: but women without children no more successful than those with! (law, "mommy-track")
- 3/4 of women would choose physics again.

Surveys & Discussion

- Fraction of women in physics differs greatly by country -no country had >35% women at PhD level ⇒ no intrinsic barrier
- Dearth of women in senior positions
- Discrimination, lower expectations, cronyism, sexual harassment
- Anti-correlation of fraction of women with salary and prestige?
- US figures of married physicists:

2/3 of women physicists married to scientists,
yet only 1/5 of male physicists are married to scientists

- Women in developing nations face greater obstacles
- Surveys do not include women who left physics - presumably many had reasons to leave - but we cannot locate them to ask!

Plenary Sessions

Roman Czujko (USA): Resources, Opportunities and Encouragement: Findings from the International Study of Women in Physics (AIP report)

Teresa Rees (UK) : Women and Science in Europe: A Review of National Policies

Claudine Hermann (France): "The European Union Report on Women and Science " (ETAN report) and a French Experience

Chen Zhili (China): Women in Physics: The View from China

Karimat Mahmoud El-Sayed (Egypt): Women in Physics: The situation in Egypt

Elisa Baggio Saitovitch (Brazil): Personal Experience as a Latin American Physicist

Masako Bando (Japan): Status of Women in Physics of Japan and Future Aspects: Findings from Questionnaire of JPS and JAPS

Iya Ipatova (Russia): Russian Women in Physics: Line of Life

Catherine Cesarsky (Germany): Women in Science: Personal Impressions

Nancy Hopkins (USA): Women Faculty in Science at MIT

Rhohini Godbole (India): Being a Woman Physicist: An Indian Perspective

Canadian Team

Marie D'Iorio, Janis McKenna (Alex), Eric Svensson, Ann McMillan

How are we doing in Canada?

Percentage of Women in Physics

1995 CAP sponsored survey:

18% BSc 13% PhD 5% faculty 2% tenured faculty

2001 CAP Update:

22% BSc 15% PhD 8% faculty 5% tenured faculty

The Canadian Challenge: Attracting and Retaining Women in Physics

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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, 11% 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. W. J. Megaw, "Gender Distribution in the World's Physics Departments", paper prepared for Gender and Science and Technology 6, Melbourne, Australia, July 14-18, 1991.
2. J. Lagowski and J. McKenna, "Physics in Canada", vol. 52, no. 2, 106 (1996).

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

Some of the survey questions sent to Physics Departments

1. 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.


As role model for girls and young women, last year Dr. Julie Payette lent her name to a student scholarship recognizing academic excellence, research ability and potential, and leadership and communication skills.

Environment Canada / Environnement Canada

National Research Council Canada / Counseil national de recherches Canada

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 %

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 %

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

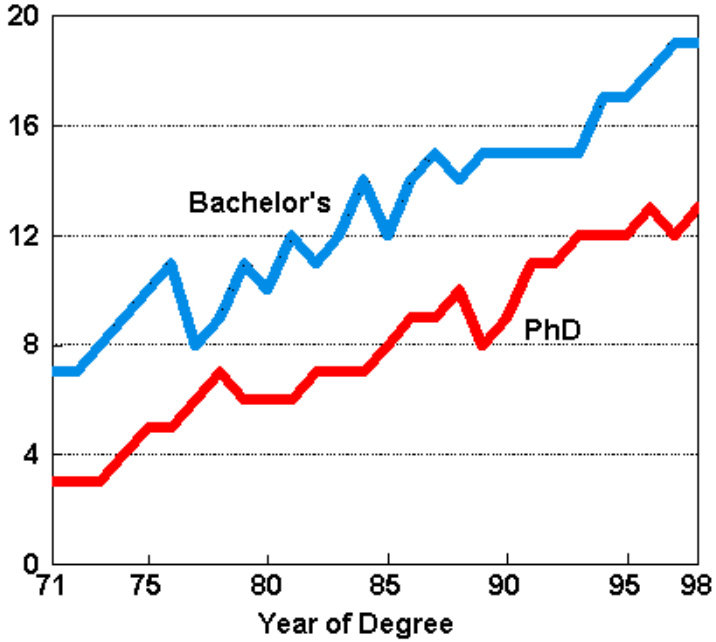
Period	1993-1995	1995-1998	1998-2001
Women faculty	No women 0 or 1	No women 0 or 1	No women 0 or 1
All Canadian Physics Dept.	45% 80%	40% 65%	26% 58%
Ph.D. granting Physics Dept.	36% 72%	31% 46%	10% 40%

NSERC Research Grants Holders in 2000

Discipline	Total	Male	Female	Not identified
Condensed matter	209	197	10	2
General	126	113	11	2
Subatomic	130	114	8	8
Total	**465**	**424**	**29**	**12**
% of total	**100%**	**91%**	**6%**	**3%**
Astro	159	143	12	4
% of total	**100%**	**90%**	**7.5%**	**2.5%**
NSERC: all science & engineering	**7552**	**6126**	**901**	**525**
% of total	**100%**	**81%**	**12%**	**7%**

US statistics

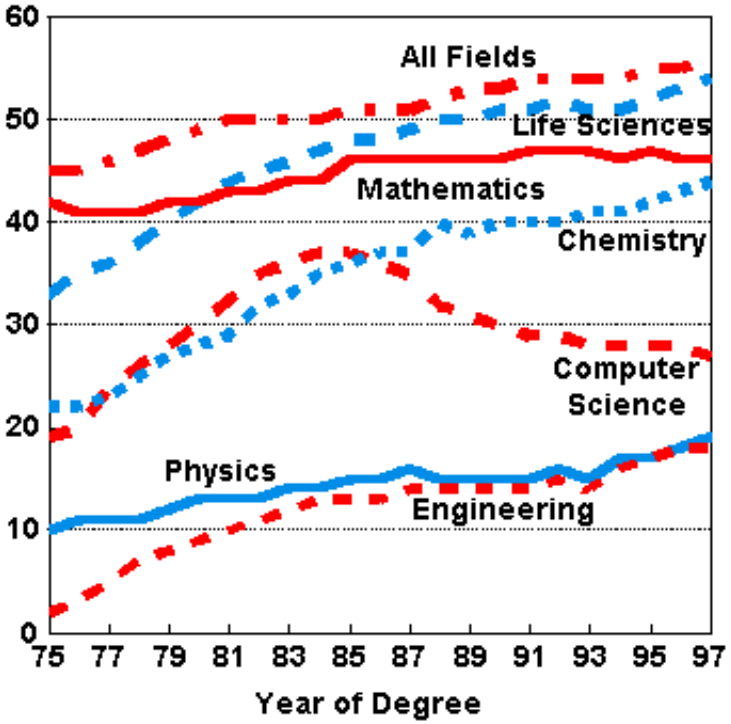
Percent of BSc & PhD degrees in USA earned by women (AIP)



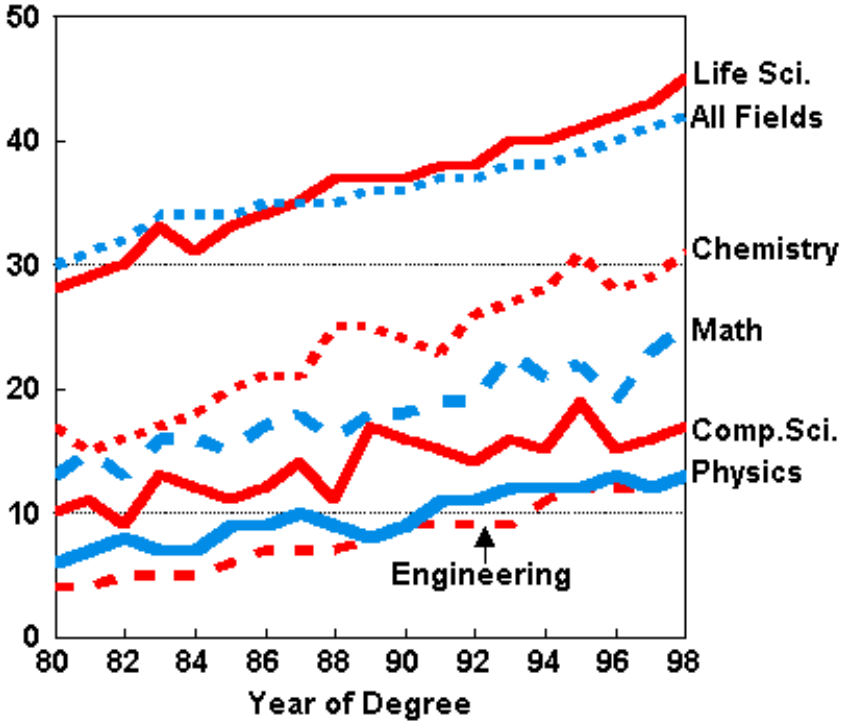
US statistics are comparable to those in Canada
(leveled off at ~13%!)

US statistics (AIP)

Percent of BScs earned by women



Percent of PhDs earned by women



Women in Physics Departments in Canada

1995 CAP sponsored survey:

45% of Physics depts had no women faculty (36% PhD granting)

80% had 0 or 1 woman faculty member (72% ")

2001 CAP Update:

26% have no women faculty (10% PhD granting)

58% have 0 or 1 woman faculty member (58% ")

Situation has improved in past 6 years

$\Rightarrow$ but we still have a long way to go

Situation in Europe

Report of ETAN (European Technology Assessment Network)

- Gathered statistics from across European Union in fields of science and technology
- Trends differ greatly from Latin to Germanic countries (culture)
- Women are more than half all undergraduates (average is > 50%!).
- *leaky pipeline* phenomenon exists within Europe too.
- Found shocking exclusion and segregation, and dearth of women in senior positions, even despite cultural differences.
- Concluded under-representation of women threatened the goals of science - in addition to being wasteful and unjust.
- "old-boys" network in place
- Attracting young people into science is challenging

Research Grants in Canada

2001 NSERC Statistics
(number of grants, not amount)

	Men	Women	Not identified
Physics:	91%	6%	3%
Astronomy:	90%	7.5%	2.5%
All NSERC science & engineering	81%	12%	7%

At this level, Physics has no problems $\Rightarrow$ unlike Swedish and British findings

Swedish Fellowship Study

Analysis of peer-review scores for postdoctoral fellowships (bio-medical) in Sweden (1997):

44% of PhDs earned by women, but only 25% of postdoc fellowships and 7% of professorial positions held by women)

1. Raw "competence scores" of 5 reviewers for all biomed postdoc fellowship applications in 1995 examined.

2. Scientific productivity measured using 6 different "objective" methods (total pubs, first author, citations, and same weighted by journal "impact" factor from external international source)

Reviewers gave women a "competence score" 2.6 times smaller than males with same scientific productivity. Additionally nepotism found - rankings higher for applicants with ties to on review committee member. Denmark, Netherlands same, UK not.

Canadian Programs

National Parental Leave: Legislated policy - mother or father, partial salary from government

Affirmative Action: NSERC UFA program - women or aboriginal peoples, partial salary support specific policies at some universities

Awareness Programs:

- CWES - 5 regional NSERC chairs in science & engineering
- WES - 25 undergrad summer research fellowships- 3 yrs
- Let's Talk Science - pairs grad students with elementary or high school classes.
- + more...

Institutional Reports

MIT: Found female faculty in science had:

- Less lab space
- Fewer professorial chairs
- More teaching assignments
- Lower salaries
- Fewer resources
- More committee work

Surprise: each generation of faculty, including those currently senior, began careers believing gender discrimination had been eliminated, but were marginalized and excluded from significant roles in their depts and at the university as they progressed through their careers

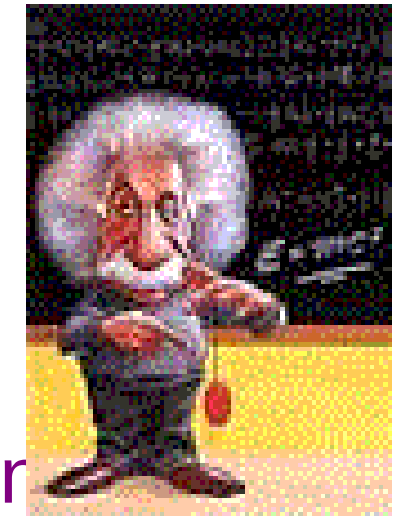
Similar findings at Caltech released shortly afterwards and about a dozen other US institutions recently released similar studies. Agree with ETAN findings.

Recommendations

Many specific recommendations were suggested during the conference. Not all are applicable to all countries or situations.

Most of these recommendations, if implemented, will improve physics for men as well as women

Attracting Girls



- Image of Physicist: nerdy, dull, male. In developing world- none
- Revise educational curricula to conn physics with medicine, biology, environment, technology + applications
- Teacher play important role in attracting boys and girls into physics
- Social/cultural situations in some countries place little value in education of girls
- Help girls network
- Raise boys to share in family responsibilities

Launching a Successful Career

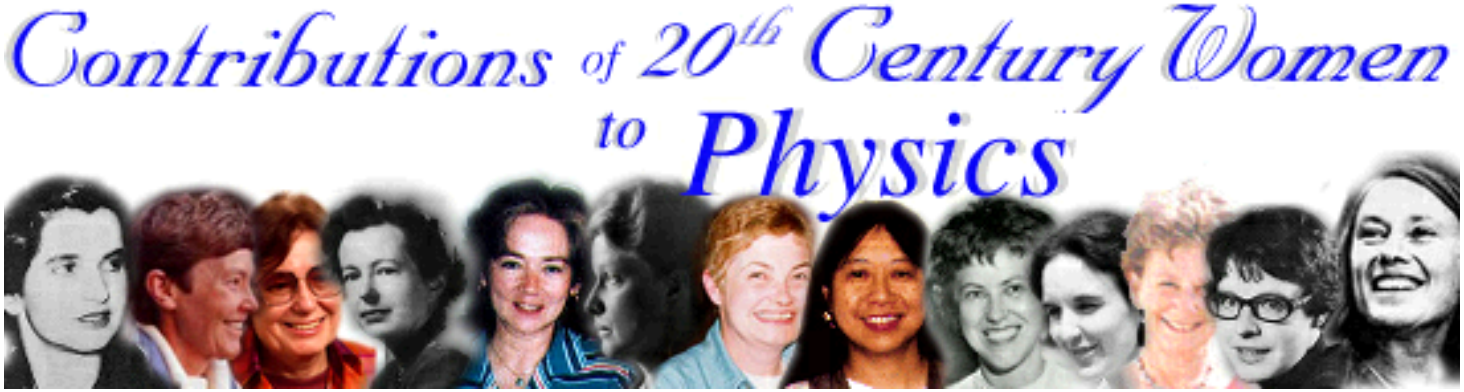
- What is success?
- Transparent and gender-blind processes for important decisions
- Sensitize teachers to gender issues
- Provide mentors for men and women
- Possibility to shorten postdoc and post-postdoc phase which have inherent insecurity and relocation requirements

Balancing Family and Career

- Respect and value family obligations
- Women carry bulk of responsibility for childcare and elder care (especially in developing nations)
- Pause "career-clock" and have flexible age limits for grants/fellowships, so as not to disadvantage people for taking time for family responsibilities (child/elders) - done for military service
- Funding sources to help people return after "family leave/service" - already done in many countries for military service
- Heed dual-career problem, creative solutions

Women in Physics Leadership

- pipeline leaks worldwide
- Appoint women to positions of leadership, include them on important committees in their institutions, countries, professional societies and IUPAP
- Involve more people in leadership. Consider innovative approaches such as term appointments and novel structures.



Learning from Regional Differences

- GOAL- not to list 'best' countries, but to learn and apply successful techniques
- Some countries pipeline dribbles (eg Turkey, Poland)
- In Africa and Southern Europe teaching is highly valued profession for women - higher fraction of women
- Former Soviet countries - 'brain drain' of male physicists to west, leaving more women in physics
- Iran, India + some other countries, physics not "male" subject. But wages and prestige are low - depressing reason for large fraction of women

Improving Institutional Structure And Climate for Physics

- make tangible resource allocation transparent (space, funding, equipment, child-care facilities…)
- address issues such as safety, sexual harassment, discrimination
- Access to resources too often via “Old Boy’s Network”- transparency
- In developing nations, tangible resources very scarce- conditions most often worse for women
- Need anti-discrimination laws legislated and enforced.

Resolutions

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

Resolutions

1. Directed at Schools and Government Sponsors:

♥Give girls same opportunities as boys

♥Parents and teachers encourage girls

♥Include methods and textbooks which interest girls and foster their success.

♥Show children ways in which physics can help improve peoples' lives.

♥Give young girls opportunity to see ways that physics has a positive impact on society

Resolutions

2. Directed at Universities (students):

- Give female students same opportunities as males
- Abolish policies that perpetuate discrimination
- Adopt policies that promote inclusion
- allow early participation in research
- providing mentoring
- expose students to important contributions physics makes to other sciences, industry and daily life.
- these practices will have a positive effect on young women, who often feel isolated & unwelcome in physics. (also welcoming environment for men, too)

Resolutions

2. Directed at Universities (Faculty & researchers):

- Even at top research institutions, women scientists have not been treated fairly with respect to their male colleagues. (not only harmful to women in science but in long run harmful to science as well).
- Universities must examine and communicate their policies and practices to make sure that they promote equity
- guarantee transparent and fair mechanisms of recruitment and promotion.
- access to research funding, facilities and sufficient time for research.

Resolutions

2. Directed at Universities (Faculty & researchers):

- Having a family should not impede women's participation in scientific careers.
- 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 is dominated by men: Women need to be included in university and physics department governance, particularly on key policy committees.

Resolutions

3. Directed at Research Institutes

- funding, facilities and sufficient time for research.
- Institute directors should make sure that policies that promote gender equity in recruitment and promotion are adopted and enforced.
- Too often "glass ceiling" is allowed to stop advancement 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 is balancing career and family life; having a family should not be allowed to impede successful participation in scientific research.

Resolutions

4. Directed at Industry:

- 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 "glass ceiling" is allowed to stop advancement of women's careers.
- Make child-care facilities and flexible working schedules are available to all.
- a leading concern is balancing career and family life; having a family should not be allowed to impede successful participation in scientific research.

Resolutions

5. Directed at Scientific Societies:

- Scientific & professional societies should play a major role in increasing the number & success of women in physics.
- work with other organizations to collect and make available statistical data on the participation of women in physics at all levels
- include women on program committees and as invited speakers for society-sponsored meetings and conferences
- include women on editorial boards of society journals.

Resolutions

6. Directed at National Governments :

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

Resolutions

7. 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. Ensure that all people have same access to research funding
- all competitions for funding should be transparent and widely publicized
- criteria for obtaining funds should be clear
- 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

Resolutions

7. 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 endorse above resolutions aimed at other groups & examine its own actions to make sure they contribute to increasing the number & success of women in physics.
- IUPAP should help communicate results of this conference to international scientific organizations in other fields.
- 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.

Resolutions

7. Directed at IUPAP:

- 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 basis of network to continue work of increasing number & success of women in physics.

Conference summary

- incredibly unique & inspiring conference
- eye-opening information shared
- Sense of hope & excitement for women in physics
- Resolutions and recommendations will improve work environment for **men** as well as **women**
- valuable opportunity to network internationally
- This is just the start

Full conference details, including articles and proceedings are now online:

`http://www.if.ufrgs.br/~barbosa/conference.html`

Reflection

British colleagues (G. Gehring):

"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."

Rosalind Franklin
1920-1958

Lise Meitner
1878-1968

Emmy Noether
1882 - 1935

Maria Goeppert Mayer
1906-1972

Mildred Spiewak
Dresselhaus, 1930-

Irène Joliot-Curie
1897-1956

Jocelyn Bell Burnell
1943-

Marie Sklodowska Curie
1867-1934