

Title: Progress and Challenges for Canadian Female Physicists

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Abstract: In recent years there has been an increase in the number of women in all academic levels in physical and applied sciences in Canada. Despite the modern feminist movement the number of women in physics continues to be less than the number of men, particularly in higher and leadership positions. As there is no rational reason for women to trail men in achieving new scientific discoveries or excel in academic teaching, the cause of this is attributed to existing gender biases in the perception and practice of science. Thus increasing the number of women in physics as well as emphasising their relevance in physics has emerged as a women



## Early physics education

In the past decade the Canadian society witnessed an upward trend in the number of short term or year long activities that can increase the interest and involvement of girls in science and in physics in particular.





## Early physics education

- Canadian academic institutions and non-profit organizations are making efforts to generate interest in science and physics at an early age, preferably before secondary school.
- Some programs run year round, while others are structured as girls-only summer camps.





## Attracting Girls to Physics

- The *Canadian Association for Girls in Science* is an organization that has chapters across the country. It “promotes, educates and supports the interest and confidence in science, technology, engineering and mathematics among girls” through a variety of diverse, fun activities such as “the physics of music, or the chemistry of cooking”.





## Attracting Girls to Physics

The *Techsploration* program in Nova Scotia, the *Ms.Infinity* and *Quantum Leaps* programs run by the Society for Canadian Women in Science and Technology in British Columbia are other examples of mentoring and networking programs which stimulate young women's interests in science.

University of New Brunswick, is organizing regular workshops for science school teachers.





## Attracting Girls to Physics

Teenage girls enrolled in the *Techsploration* program in Nova Scotia interact with and are mentored by female role models well matched for the age group of the students working in areas of science, trades and technology.

The girls enrolled in this program are informed about diverse career choices, in up to 150 professions.



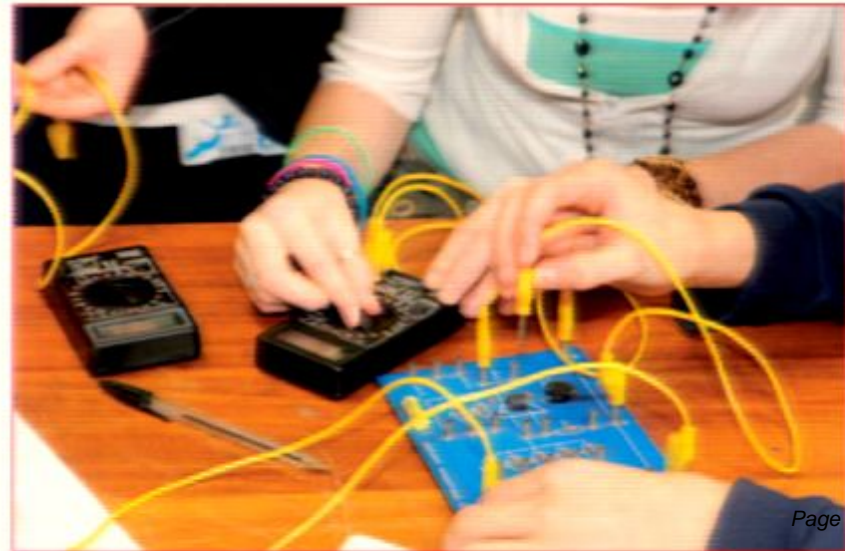


## Attracting Girls to Physics

Girls in the same age group are targeted by the *Operation Minerva*, a program available nationwide that is a one day job shadowing/ workshop for grade 9 and 10 girls with interest in science, mathematics, engineering or technology careers.



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Page 7/57



## Attracting Girls to Physics

The Perimeter Institute's outreach team promotes the power and fun of physics to students and the public. They host popular public lectures, EinsteinPlus Teacher Workshops, an International Summer School for Young Physicists and have produced an award-winning documentary.







## Early physics education

Academic units and organizations across Canada also support **Science Fairs**

In Alberta, over **60%** of participants in local high school science fairs are girls; in British Columbia, **52%** are girls

➤ **Physics Olympics** for High School students take place in several Canadian provinces - in British Columbia, typically 80 high schools (over 600 students - girls and boys) participate in annual Physics Olympics





## Early physics education

- Scientists make **visits to schools** in their district
- The teachers are also invited to **visit the academic physics units**, meet and interact with faculty members
- They jointly develop outreach activities that, among other things, contribute to attracting female students to physics.





## Early physics education

- Teachers get ideas for new physics related activities that can be used to enrich the existent curriculum.
- Occasionally teachers receive equipment for physics demos either in kits or as individual pieces that they can use to design new experiments for their students.





## Early physics education

A very good example is the *Innovators in the Schools* program available in British Columbia for grade K-12 students.





## Early physics education

A recent survey of Canadian teens aged 16 to 18 showed that only a third of them are interested in taking a science course at the post-secondary level, regardless of all science and technology-based career opportunities available to them in Canada.





## Early physics education

“**Let's Talk Science**” is an award-winning, national, charitable organization that delivers science learning programs and services to children and teenagers.





## Early physics education

Women make up more than half of all university students and so few of all mathematics and science students that to achieve parity in our undergraduate classes, we would have to sway less than 10% of all incoming women to change their major.

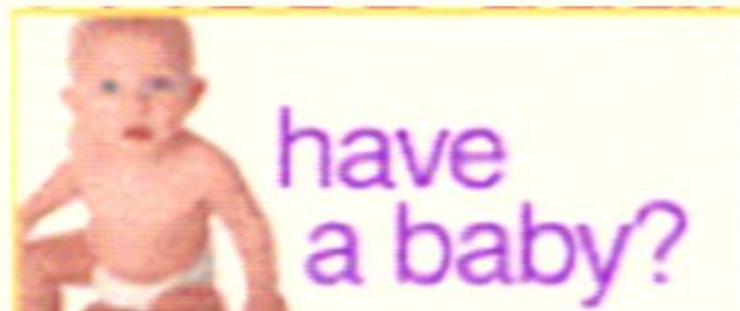




## Leaving and entering a career in physics

For many women in physics, their responsibilities include family obligations, maternity, child care and sometimes care of elderly parents.

The child bearing age of a woman coincides with the most active time of a physicist's career, and to facilitate family life many women choose to take a break in their career. Particularly in regions where child care facilities are not available this issue is important.







## **Leaving and entering a career in physics**

For many women faculty members the availability of day care services at the location of a given conference or workshop, can make the difference between attending and not attending that activity.

Even though conference or workshop organizers are aware of the benefits of having day care services available to the participants of their event, in our country such services are offered on an ad-hoc basis.



## ***Balancing Family and a Career***

Several programs assist in balancing family and career for women in physics in Canada:

- **Paid parental leave benefits**

- part of the Canadian unemployment insurance system
- and may be taken by either parent, for a newborn or adopted child for anyone with a permanent job in academia, industry or government

- **Paid parental leave for students and postdocs**

- NSERC may assist in making available paid maternity leave for graduate students and postdoctoral researchers
- can eliminate career gaps which tend to have a detrimental effect on securing a subsequent position or job



## The “*Maternal Wall*” in Canadian Academia

- Highly educated Canadian women may not encounter gender discrimination until they encounter the so called “*maternal wall*” which hinders advancement in their professional careers
- organizations such as the *Association for Research on Mothering founded in Toronto at York University*, are making efforts to find strategies to help mothers cope with the “*maternal wall*” in academia.



In Canadian academia, having women take a one year parental leave is **not common**. Most universities support parental leave with full pay up to five months and beyond which financial support is provided by unemployment insurance and the Government of Canada.

At all levels in academia career gaps tend to have a detrimental effect on securing a subsequent position or job.

**The M. Hildred Blewett Fellowship was established to enable women to return to physics research careers .**



## Networking

- The process of entering or re-entering the workforce after a career break can be enhanced by networking efforts.
- Universities organize workshops on technical writing, writing research grant proposals, time management and project management
- Often senior faculty members mentor early-career faculty members and help them develop negotiation and team working skills as well as teach them how to build up research collaborations.



## ***Balancing Family and a Career***

Several programs assist in balancing family and career for women in physics in Canada:

- **Compassionate Care Leave**

- for people who must be absent from work to care for a gravely ill family member

- **On-campus Child-care**

- most Canadian universities have insufficient capacity to fill the campus community's childcare needs, resulting in wait-lists hundreds long

- **Pause of the Tenure Clock**

- many, but not all, Canadian universities have policies by which faculty may extend the pre-tenure period, typically by one year per pregnancy



## **Dual Career Couples or “the two-body problem”**

- Recent years have been marked by steady increased enrollment of women in physics graduate programs in Canada
- However, we do **not** observe an increase at the same rate in the numbers of women in the physics workforce.
- **Possible reason:** more than half of married women physicists are married to physicists or other Ph.D. scientists and securing two jobs in the same geographical area may be a challenge.



## **Dual Career Couples or “the two-body problem”**

Canadian attempts to solve this problem:

Academic institutions that have **no university-wide policies** to solve the problem but are willing to solve it on a **case-by-case** base

- The success rate depends on the partner’s field and qualifications, and on the availability of openings at the institution
- Promises and indications made at the time of hiring for a second full-time or tenure-track position may be unfulfilled for years
- The “**trailing spouse**” may end up under-employed and dissatisfied





## **Dual Career Couples or “the two-body problem”**

Canadian attempts to solve this problem (continued):

- **The University Faculty Awards (UFA) program of National Sciences and Engineering Research Council (NSERC) of Canada**

- Run during 1991 to 2009 (including its predecessor WFA)
- 5 year program
- Provided incentives to universities to offer a position to a woman or minority physicist

- **Chairs for Women in Science and Engineering Program**

- Funded in 1996
- 5 year program ( renewable once )



## **Dual Career Couples or “the two-body problem”**

Canadian attempts to solve this problem (continued):

- **Academic institutions that have implemented a spousal hiring program**
  - may arrange a spousal/partner hire as faculty or academic staff, or they may enlist a local “*head-hunter*” to help the spouse find suitable employment
  - sometimes offer the option of a “*shared*” or “*split*” position, which may be attractive for those with young families



## ***What is Canadian Association of Physicists (CAP) and what it can do for women in physics***

- At the national level, the overall climate for women physicists both in academia and in industry has improved significantly over the past decade. Organizations such as the CAP and the Canadian Association of University Teachers (CAUT) *are actively working towards minimizing the socio-economic* and professional gaps between women and men.



## The CAP Committee to Encourage Women in Physics (CEWIP)

- CEWIP was initiated in 1983 and is composed of both men and women
- It has been involved in many activities, including, among other things:
  - works to present positive images of physics and physicists to counteract the negative stereotypes prevalent in popular culture
  - organizing panel discussions on programs that encourage female physicists in Canada and a plenary session at the CAP annual congress
  - proposing female speakers for the CAP Lecture Tour
  - producing a directory of women in physics in Canada
  - organizes delegations to attend the International Conferences on Women in Physics



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## Professional Participation Rates

• CAP, through its activities, encourages universities to revise physics curricula and programs to include interdisciplinary studies or combined honors /dual majors (e.g. medical physics, biophysics, environmental physics...) which often encourage the participation of women.

• In recent years several Canadian Physics Departments have conducted an *external critical assessment of the climate and environment for women in their physics departments.*



## Professional Participation Rates

- In the past decade Universities in Canada have made efforts to address the “**chilly climate**” issue for women in science and create a friendly environment for its female faculty members.
- Several measures have been implemented at institutional level to support early-career female faculty members.
- Such measures include **career advice, mentoring and training, provision of funds for professional development and training of faculty members** that are in charge of hiring and promotions.





Very limited opportunity for paid Women's work when Grandma & Great-grandma were young



We've come a long way, Baby!



## Professional Participation Rates

Numerous Canadian Universities have developed and implemented **tools aimed at challenging gender stereotypes in science.**

There are two ways to achieve it:

- by **offering our university's community access to images and representations of women and science.**
- particular attention is devoted to **fighting those mechanisms that attach a gender to disciplines, topics or tasks.**

In addition, the **curriculums are revised** to include relevant gender studies, institutional or organizational arrangements are made to increase the number of women in research leadership positions.



## Professional Participation Rates

- Supporting women's leadership in science is a strategy pursued by many Universities.
- Women faculty members enrolled in a traditional academic career, have available resources to support their mentoring and professional development, tools for nominations for Research Chair positions, direct support to access boards and committees.
- Many Universities have developed tools aimed at strengthening women's visibility and role in the communication flow among scientists and to the general public.
- One such example is the Women Scholars Speaker Series at University of Lethbridge, with the mandate to "highlight the research and/or careers of women both within the institution and beyond in order to encourage and inspire our women students."



## **Moving towards a gender aware science and physics**

> The image and representation of physics, is strongly gendered as **masculine**, and the increasing participation of women does not automatically mean that this is going to change.

> The image and representation of physics and physicists also have remarkable effects on both women and men's perception of their attitudes and capabilities, and to influence career choices and decisions about the allocation of tasks and promotions.



# Women in former male-dominated fields





## Moving towards a gender aware science and physics

> Canada has promoted an analysis on gender and science research aimed at providing an exhaustive overview and analysis of all research projects carried out in this issue at national and regional levels, in the past decade.

> The final results of this effort will likely offer new insights into dimensions, risks and features of male-dominated understandings of disciplines such as physics.



## Overcoming gender stereotypes in physics

> Programs aimed at introducing awareness of the gender perspective in science and technology may represent an antidote to some of the most serious impediments contributing to the “leaky pipeline” phenomenon affecting women in research.

> In particular, they help women overcome barriers connected with the sense of not being adequately acknowledged in a masculine-gendered representation of scientific knowledge and the stereotypes concerning the cognitive skills of women and men.

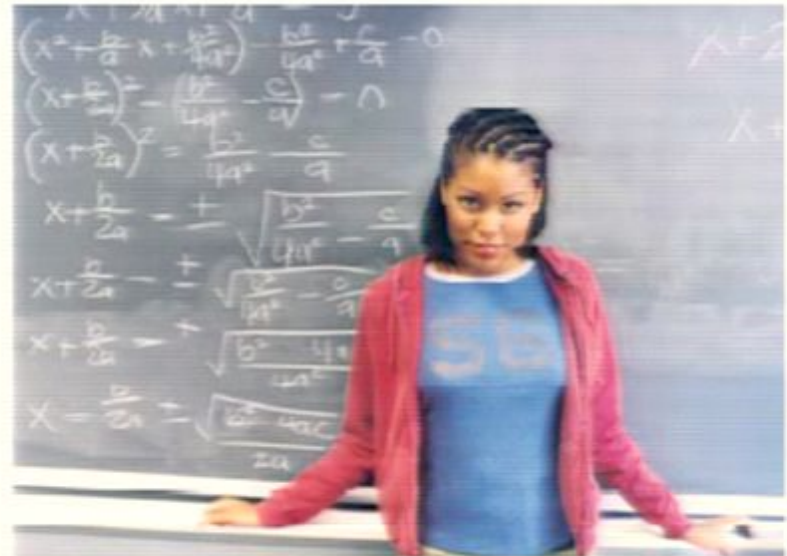


## Start of Leaky Pipeline

British Columbia High School

Optional grade 12 participation:

CHEM12 49% female  
MATH 12 47% female  
BIOL 12 62% female  
PHYS 12 30% female  
GEOL 12 47% female



Bachelor's degree in STEM: Large disproportional leak for women





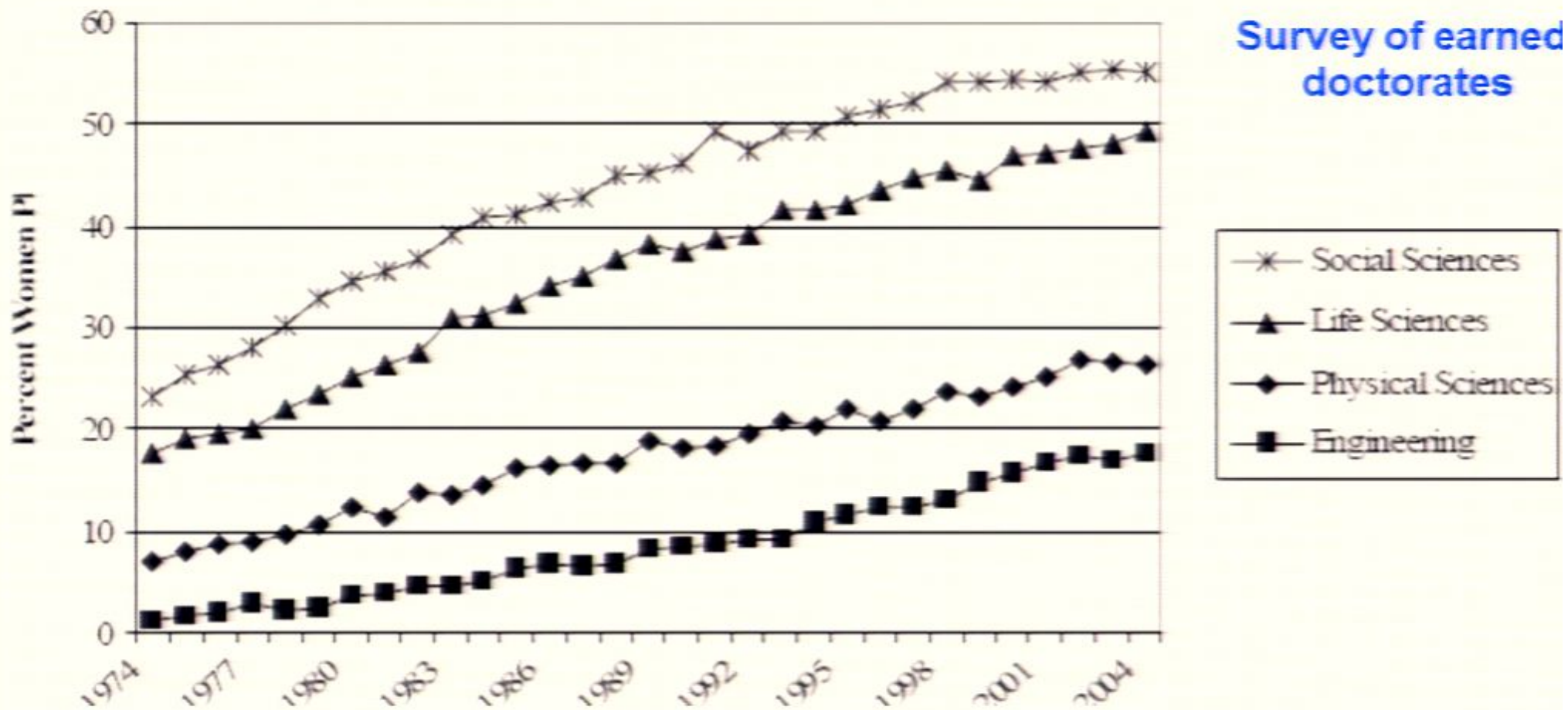
# Women have finally caught up?



- In each of the 10 Canadian provinces, more women than men are enrolled fulltime in university
- Overall in Canada, 56% of fulltime university students are women (2009)
- 54% of fulltime community college career program students are women (2000 most recent available)

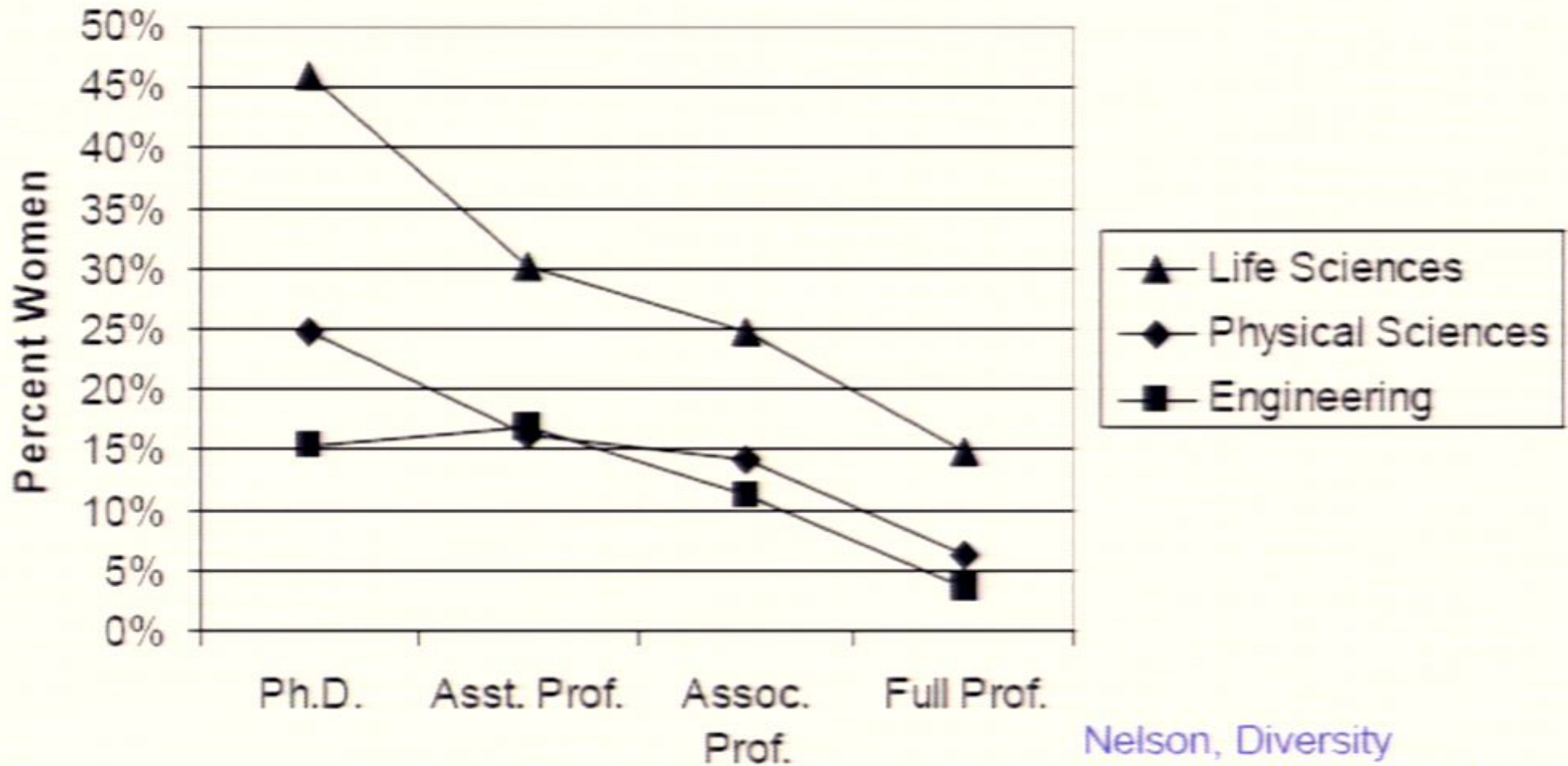


## The problem





## The problem



Nelson, Diversity  
Surveys 2005 (Top 50)



## Overcoming gender stereotypes in physics

- Gender stereotypes operate, often **invisibly**, affecting women's attitudes towards physics.
- The perception and internalization of stereotypes appear to have a very strong role in producing **low self-esteem and dynamics of self-exclusion** from scientific studies and high-level scientific careers.
- The stereotyped images of physics and “the physicist”, on the other hand, reflect features that are typically presented as unchangeable and refer to a taken-for-granted masculine model.



## Gender aware physics

- Having to deal with the long-lasting belief in the objectivity of science, programs are often engaged in Canada in what can be considered **cultural battles**, aimed at dismantling the myth of gender-neutral science.
- Programs in this area tend to concentrate on activities such as **awareness-raising, education, training and dissemination**, as well as in **action-research**, that tries to find evidence for the claim of the male-gendered nature of science and provide a basis for concrete programs aimed at legitimizing women's approaches and points of view on scientific research and innovation.



## Gender aware physics

The belief in the gender-blindness of science is, as mentioned, one of the strongest yet most invisible barriers to women progressing in substantial numbers in S&T sectors.

Putting such belief to the test and showing its shortfalls represent the first steps in an awareness-raising strategy which is a precondition for change.

The effort towards equality matches the search for excellence, both in scientific research and in technological development, finally taking into account women's visions, needs and expectations.

Education plays a key role here.



## Gender aware physics

Teaching contents and methodologies, indeed, directly affect the conception new generations of students will form of their disciplines

to “strengthen the pipeline”, that is, to increase the number of girls and women in physics education and careers, programs are carried out that critically review and question traditional teaching methods and test new approaches, or elaborate new curricula and provide guidelines.





## Gender aware physics

Recognizing and documenting the existence of different gender approaches to science and technology, without buying simplistic gender stereotypes, has **the twofold objective** of:

identifying **subtle** and often hard to detect barriers to women's full participation in science and technology disciplines

finding the **key** to making the most of their potential, innovating the fields they contribute to.

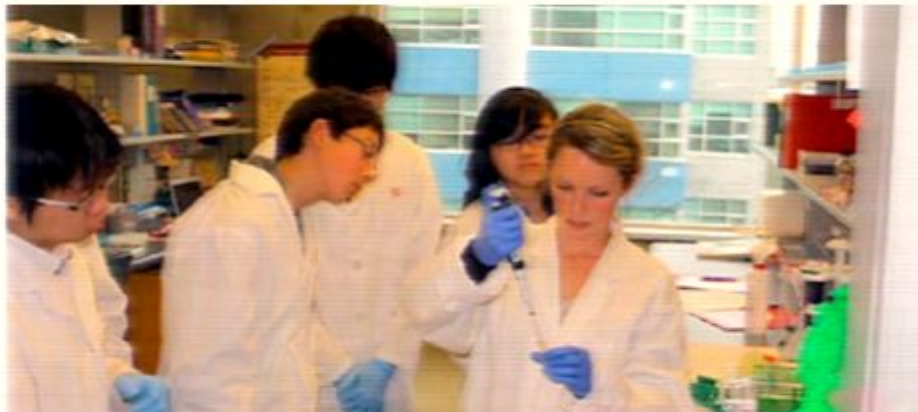






## Overcoming gender stereotypes in physics

- Debunking the myths perpetuating gender stereotypes is the main measure to deal with them.
- Concrete actions encompass conducting and disseminating studies showing their failure – which is particularly effective in a scientific environment – but also organizing information campaigns in the traditional media and on the web.





## Overcoming gender stereotypes in physics

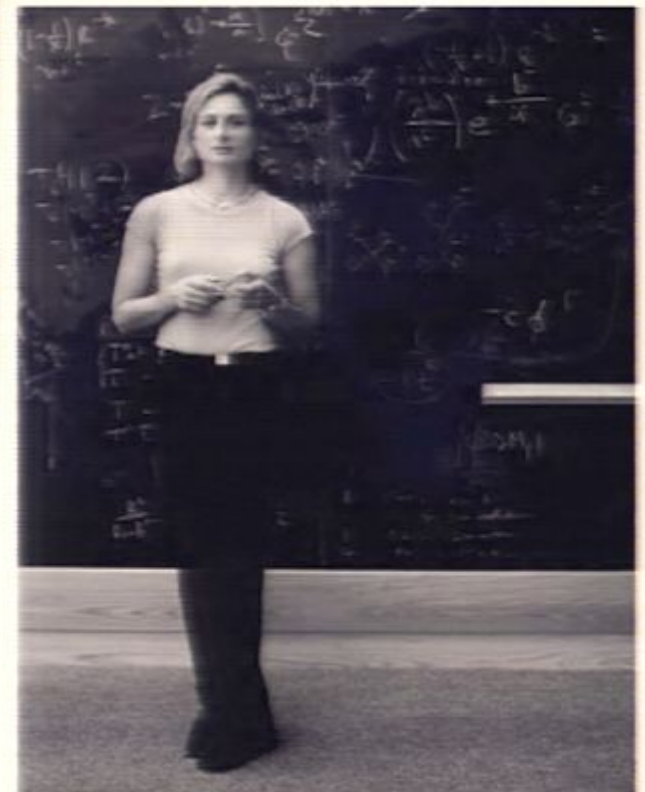
The percentage of female doctoral students is 30% and the percentage of females enrolled in undergraduate courses in Mathematics and Physical sciences was 39.1% in 2008-2009.

The ideal situation where young female physicists are equally comfortable in identifying themselves as the next Galileo or Newton has not been achieved.

Nobel prizes and awards for discoveries are dominated by male physicists, and strong role models to inspire the next generation are not visible except for a few in the Canadian physics community.



# Women in all fields of science/technology



Lisa Randall



## Overcoming gender stereotypes in physics

It is hard to differentiate the female influence in physics.

But females are under-represented in the physics profession and that remains to be a topic of concern in gender studies.

There is no evidence as of yet that clearly says that physics is suited for the male brain, and in fact at a young age females perform equally in physics.

Yet, despite a steady increase the percentage of female researchers in Mathematical and Physical sciences in academic positions in Canada is 17.1% (2008-2009).



The number of women in physics decreases as their career path progresses. This is named as **the leaky pipeline**. The reason for this is attributed to maternity, family obligations which acquire importance for a female precisely at the time career building should be priority. Dual career couples usually find it difficult to find jobs at the same place, and the female being younger usually trails the male and takes up temporary positions.

In recent years there has been a firm upward trend in number of female faculty in Mathematical and Physical Sciences, though the percentage of doctoral and undergraduate students has remained static in the last decade.

This might be an indication that **the leaky pipeline has been resisted**



## Different Worldviews





## ***Conclusion***

- In recent years there has been an increase in the number of women in all academic levels in physical and applied sciences in Canada
- The fraction of women at all stages in the pipeline, from undergraduate students to tenured faculty, continues to increase in physics, but progress is slow
- At the national level, the overall climate for women physicists both in academia and industry has improved significantly over the past decade



**Thank You!**

***“The question is not why there have not been more women in science; the question is rather why we have not heard more about them.” Naomi Oreskes, historian of science***





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