

How can we draw more women to physics

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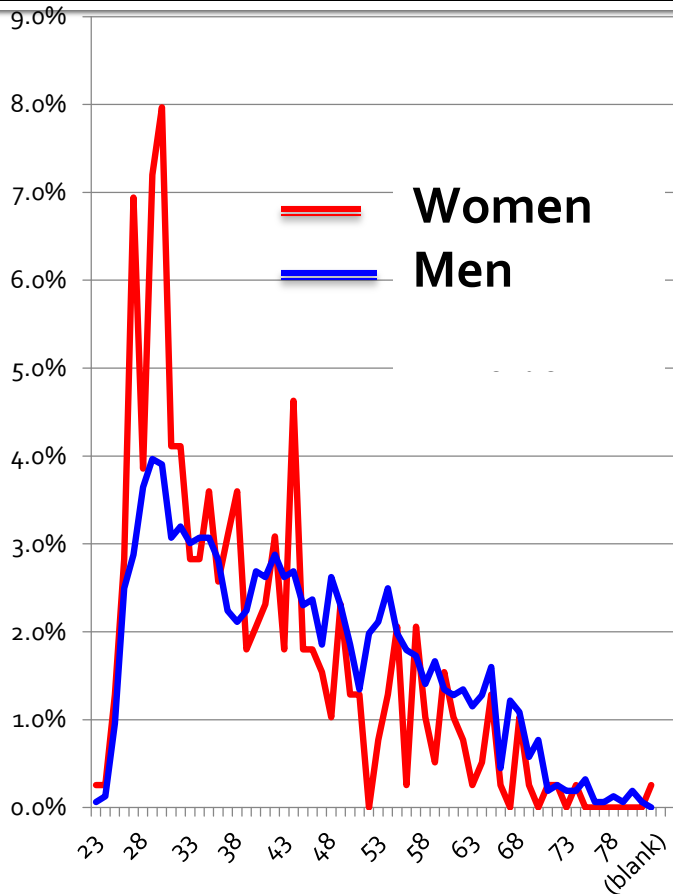
Outline

- **Some statistics from ATLAS and CERN**
- **Easy things to do to improve the situation**

ATLAS Collaboration: 38 countries, 3000 people



Fraction of women in ATLAS as on October 2012



Based on qualified authors

(after 1 year of service work)

1952 scientific authors:

- 389 women
- **19.9% women** (was 15.6% in May 2008)

■ below the age of 36:

- 50% of all women; 33% of all men

■ of all ATLAS authors:

- above the age of 50: 12% are women
- above the age of 36: 16% are women
- below the age of 30: 30% are women

Many young women are joining ATLAS

% of women by affiliation and nationality

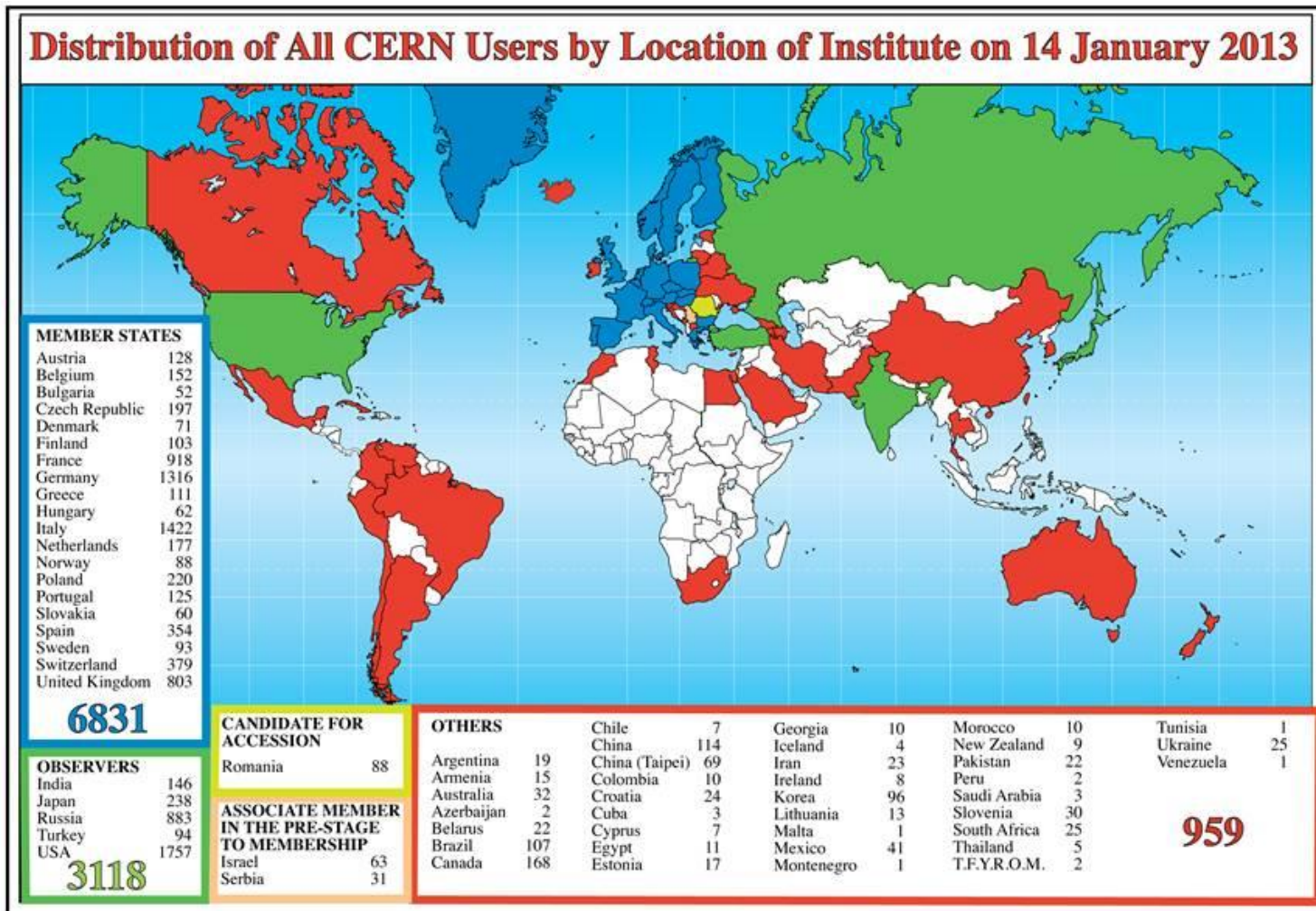
country of affiliation	% in ATLAS by affiliation	% of women by affiliation	% of women by nationality	country of affiliation	% in ATLAS by affiliation	% of women by affiliation	% of women by nationality
USA	18,2%	16,1%	11,3%	China	1,7%	5,9%	12,0%
Germany	13,9%	20,7%	15,2%	Israel	1,6%	18,8%	19,2%
UK	10,1%	23,2%	18,1%	Switzerland	1,4%	25,9%	16,0%
Italy	7,7%	25,8%	31,9%	Greece	1,3%	34,6%	40,5%
France	7,0%	29,2%	23,6%	Poland	1,2%	30,4%	31,3%
Russia	5,1%	5,1%	6,1%	Norway	0,9%	27,8%	28,6%
Japan	4,1%	4,9%	7,5%	Portugal	0,9%	22,2%	20,8%
Canada	3,8%	20,0%	22,2%	Romania	0,8%	46,7%	42,9%
Spain	2,9%	35,7%	35,6%	Australia	0,7%	7,1%	0,0%
Czech	2,5%	6,3%	8,9%	Turkey	0,7%	21,4%	26,3%
Netherland	1,9%	27,0%	11,1%	Denmark	0,6%	16,7%	9,1%
Sweden	1,8%	25,7%	26,7%	Brazil	0,5%	30,0%	23,1%

Women on ATLAS per country of affiliation above ATLAS average in 2012

<u>Country of affiliation</u>	<u># women</u>	<u>% women</u>
Romania	7	46,7%
Spain	20	35,7%
Greece	9	34,6%
Poland	7	30,4%
France	40	29,2%
Norway	5	27,8%
Netherland	10	27,0%
Switzerland	7	25,9%
Italy	39	25,8%
Sweden	9	25,7%
UK	46	23,2%
Portugal	4	22,2%
Germany	56	20,7%
Canada	15	20,0%

Using only countries with > 14 people; these countries = 54% of ATLAS

Country of hire of CERN Users



% of women physicists at CERN by end of 2012

physicists	men	women	% women
CERN staff	71	8	10.1%
Users	9217	1602	17.4%

Low fraction for CERN partly explained by the lack of graduate students

Summer Student Program	Member states program		Non-member states program	
	applied	admitted	applied	admitted
2009				
2010	21%	27%	23%	30%
2011	22%	31%	21%	23%
2012	24%	29%	21%	26%
2013	25%	28%	23%	31%

Are women less apt at physics than men?

<http://www.sciencemag.org/content/314/5799/599.full>

- Metadata studies summarizing >5000 individual studies, based on the testing of ~7 million people.
- Using d statistics: $d = (M_M - M_F)/s_w$ where M_M is the mean score for males, M_F is the mean score for females, and s_w is the combined standard deviation
- The d statistic measures the distance between male and female means, in standard deviation units.
- 78% of the effects for psychological gender differences were small or near zero
 - mathematics problem-solving, $d = 0.08$
 - leadership effectiveness, $d = -0.02$
- Emphasis on gender differences in the popular literature reinforces stereotypes that girls lack mathematical and scientific aptitude
- To neutralize traditional stereotypes about girls' lack of ability and interest in mathematics and science, we need to increase awareness of gender similarities
- Rather than focusing on gender differences mathematics and science educators would profitably examine ways to increase awareness of the similarities in performance and in ability to succeed

What's the best way to attract more women in physics?

Great study from Harvard (PRiSE study)

<http://blogs.scientificamerican.com/guest-blog/2011/03/29/can-we-declare-victory-for-women-in-their-participation-in-science-not-yet/>

- Students who pursue studies in physics need a strong **“physics identity”**
- This is true for both male and female students, but female students tend to believe in themselves less, contributing to the difficulties they can encounter in physics.

What is a strong “physics identity”?

“Physics identity” is the degree to which students perceive themselves to be the right type of person for physics.

- having confidence in their ability to complete the right tasks (for example, understand and solve difficult physics problems)
- having a strong interest in physics
- having others recognize them as the right type of person
- being successful in physics
- choosing to participate in physics-related activities.

Students with a strong physics identity are more likely to remain in physics and pursue it as a career.

What helps build a strong “physics identity”

- Students liked
 - Having opportunities for peer teaching
 - Receiving encouragement from teachers
 - Discussing in class about the benefits of being a scientist
- Teachers should:
 - Discuss current and cutting-edge physics topics
 - Encourage student questions
 - Set up labs addressing students’ beliefs about the world

What about women in particular?

The Prize study researchers found that the following experiences had no real effect on building a strong physics identity for young girls

- providing positive female science role models
- creating opportunities for collaborative group work
- discussing the lives of female scientists.

Discussing the under-representation of women in science makes a huge difference

- Not just highlighting women scientists like Marie Curie but instead talking directly about the fact that there are few women in physics
- Talking about it helps young women see the problem comes from society, not from them
- Female students who had these discussions in high school had significantly stronger physics identities
- These discussions had no adverse impact on young men

Conclusions of one author of the *Prise* study

- Social influences are still very important for determining if students will pursue a career in physics.
- Student's opinions are far from fixed, and good science teachers can have an important effect on their students' physics identities.
- Most importantly, teachers who did something as simple as acknowledging the gender imbalance in physics could be enough to help encourage female students toward a physics career.

Recommendations from young women physicists

<http://www.quantumdiaries.org/2013/04/03/how-to-attract-hire-and-retain-more-women-in-science/>

To attract more women:

1. Fight gender stereotypes at all levels
2. Help young people build a strong “physics identity”
3. Provide role models and mentors for young women

To hire more women:

1. Implement anonymous job application processes
2. Implement equitable parental leaves
3. Add spousal considerations to hiring processes

To retain more women:

1. Provide mentors for young women starting their careers
2. Have broad discussions about gender issues at large scientific meetings
3. Hold scientific meetings for women

Fight stereotypes at all levels

- improve the representation of women in textbooks
- include female characters in the phrasing of problems
 - A study showed women score higher
- increase the visibility of women scientists in the general culture by providing more female contacts for the media
- use gender-neutral language when referring to scientists or specify both genders

Using non-sexist language

PREMIÈRE PARTIE

LA THÉORIE DE LA RELATIVITÉ RESTREINTE (1)

1. Le contenu physique des propositions géométriques

Sans doute avez-vous, cher lecteur, quand vous étiez jeune garçon, fait la connaissance du superbe édifice de la Géométrie d'Euclide, et vous vous rappelez peut-être, avec plus de respect que de plaisir, cette imposante construction sur le haut escalier de laquelle des maîtres consciencieux vous forçaient de monter pendant des heures innombrables. En vertu de ce passé vous traiteriez

PART I THE SPECIAL THEORY OF RELATIVITY

I PHYSICAL MEANING OF GEOMETRICAL PROPOSITIONS

IN your schooldays most of you who read this book made acquaintance with the noble building of Euclid's geometry, and you remember—perhaps with more respect than love—the magnificent structure, on the lofty staircase of which you were chased about for uncounted hours by conscientious teachers. By reason of

Introduction to Einstein's book on
relativity:
the English and French translations
and the original in German

§ 1 Physikalischer Inhalt geometrischer Sätze

Gewiß hast auch du, lieber Leser, als Knabe oder Mädchen mit dem stolzen Gebäude der Geometrie EUKLIDS Bekanntschaft gemacht und erinnerst dich vielleicht mit mehr Achtung als Liebe an den stolzen Bau, auf dessen hohen Treppen du von gewissenhaften Fachlehrern in ungezählten Stunden umhergejagt wurdest. Gewiß

Provide role models and mentors for young women

- Do it at all stages.
- Hold career fairs to reinforce girls' self-esteem and provide a context where they can discuss with other girls facing similar challenges
- Provide places where young women can talk with peers and find support.

Conclusion

- The number of women in physics and HEP is increasing
- Reinforcing “physics identity” helps recruiting more young women but also more young men.
- Discussing the poor representation of women in physics helps strengthening “physics identity”
- There are many ways to improve the situation: talking about it is already a good step

**Remember: everything that is good for women
is good for everyone**

**All what I have said is also good for other
under-represented groups**

**Having a more diverse community means
tapping into more potential**
