GENERA - Gender in Physics Day Austria

24th of May 2017, 13:00 – 17:30

TUtheSky, Getreidemarkt 9, 1060 Vienna

Moderation: Anita Zieher

GENERA is a Horizon 2020 funded project to promote the implementation of gender equality plans in research and funding organizations in the field of physics which is – despite differences between countries and sub-fields of physics - characterized by a low representation of women. The main objective is, therefore, to propose and create organisational structures allowing physics research in Europe to benefit from the greater presence of talented women at all levels, and which can open up more opportunities for women to create successful careers in physics research and in related fields. The Consortium consists of 13 partners and 3 associated partners and 11 observers.

What are the aims of the GENERA - Gender in Physics Day?

The series Gender in Physics Day (GiPD) is aiming to raise the awareness for gender inequality in physics and what can be done against it. Therefore, the Gender in Physics Day offered the opportunity to discuss the reasons for the underrepresentation of women in physics but also to highlight possible strategies and measures how to create a more gender equal work environment and culture in physics research organizations. Recognized experts on gender equality in physics were invited to present their research findings and to propose strategies for change.

Keynotes

- **Thomas Berghoefer** (DESY, Hamburg, Germany)
  Coordinator of the GENERA project introduced the aims and the current status of the project.
  http://genera-project.com/
- **Tomas Brage** (Lund University, Sweden)
  Discussed in his keynote the main causes and circumstances resulting in the underrepresentation of women in physics. He provided recommendations on how to make progress in the direction of more gender equality in physics.
  https://www.youtube.com/watch?v=jdroi9BuUg4
- **Rachel Ivie** (Statistical Research Center of the American Institute of Physics)
  Discussed her research findings about why people leave the field of astronomy and astrophysics and why gender is a relevant factor in this complex process. Based on her findings, recommendations were formulated to increase the retention of women in physics.
  https://journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.12.020109

Panel discussion

The panel discussion provided opportunities for the audience to engage in discussions with representatives of the physics community in Austria and with the gender equality experts. It provided room for reflecting the situation of gender equality in physics in Austria and to discuss how to promote gender equality in physics more effectively. The panelists were:

- **Ulrike Diebold**, Deputy Head, Institute for Applied Physics, TU Wien
- **Rainer Blatt**, Managing and Research Director, Institute for Quantum Optics and Quantum Information, ÖAW
- **Joachim Burgdörfer**, Dean of Faculty of Physics, TU Wien
- **Theresa Lüftinger**, Project Leader and Lecturer, University of Vienna, Faculty of Earth Sciences, Geography and Astronomy, Department of Astrophysics
- **Tomas Brage,** Professor/Director of Education, Department of Physics, Lund University
- **Rachel Ivie,** Director of the Statistical Research Center of the American Institute of Physics

The following questions guided the panel discussion:

- What are the main challenges gender equality faces in your research organization and in physics, respectively?
- What is your experience with gender inequality and the efforts to promote gender equality?
- What lessons can be learned? Which measures and initiatives are suitable to promote gender equality?

The panel discussion ended with a summary of the main findings of what needs to be done to promote gender equality in Austrian physics research organizations in future.

SUMMARY and CONCLUSIONS

Opening and welcome address

Anna Steiger (Vice Rector for Human Resources and Gender) pointed out, that although the topic of Physics does not point to any gender dimension in terms of content, gender is relevant in terms of participation of women among researchers and students. The GENERA project provides valuable tools in terms of its Roadmap and Toolbox to work on measures to improve the participation of women researchers.

Gregor Weihs (Vice president of the Austrian Science Fund (FWF) and Institute for Experimental Physics, University of Innsbruck) pointed out that the topic of Gender Issues has its prominent place in the strategic discussion at the FWF and that the FWF is working on an overarching Gender and Diversity Strategy.

At the moment there are several measures in place based on the embedded Gender Mainstreaming strategy of the FWF to provide equal opportunities for female and male researchers. Support of female researchers is ongoing by means of career development programmes for women.

Helene Schiffbänker (JOANNEUM RESEARCH) pointed out that GIPDs are meant to increase awareness within the national communities of researchers and representatives of research organisations. In the context of such an event stakeholders should engage, exchange, and discuss specific problems of the physic research community.

Introduction of the GENERA project

- **Thomas Berghöfer** (DESY), Coordinator of GENERA

Gave a brief overview on the objectives, activities, and tools of the GENERA project. He pointed out that a Gender Equality Plan (GEP), which is meant to be implemented by each partner of the GENERA project, defines objectives and measures and helps to improve gender equality at the organisations involved. In addition the project should allow mutual learning through the exchange of best practise strategies.

Keynote 1: Gender and Physics – what does recent research and experiences say?

- **Tomas Brage** (Lund University)

In his talk Tomas Brage presented data on the vertical and horizontal segregation at research institutions in Europe as well as various national research and student communities. Based on these empirical findings the main reasons for the underrepresentation of women in physics were discussed. The first explanation referred to the male dominated culture of physics which leads to a low entrance rate of female students as well as the loss of female researchers in the course of their career paths. This masculine culture of physics contributes to a situation in which

women do feel unfit for such research organizations. Ingrained in this masculine culture is another factor – an implicit gender bias – which disfavours or even discriminates against women in subtle and unconscious ways: This implicit gender bias makes it harder for women to be successful in such a culture: women get fewer research grants, less support and career guidance by supervisors or are less often recruited or promoted. Although there is empirical evidence for this implicit gender bias the myth of meritocracy still prevails and makes it even harder for women to compete with their male colleagues. Therefore the main recommendations were targeted towards changing this masculine culture in physics and towards raising the awareness about the implicit gender bias at work in such a culture.

Keynote 2: Women's and men's career choices in astronomy and astrophysics

- **Rachel Ivie** (Statistical Research Center of the American Institute of Physics)

The presentation visualized results of a longitudinal study of a cohort of graduate students in astronomy, astrophysics and related fields which followed their career between 2007/08 and 2016/17. The panel data is based on three surveys at different points in time: the first survey was conducted during 2007/08, the second during 2012/13 and the third survey was conducted during 2015/16. The model presented tried to identify the factors explaining the attrition from physics and astronomy. The main hypothesis guiding the research was that women would be more likely than men to work outside of astronomy, astrophysics and physics. But the results show that gender did not have a direct effect on the retention of researchers in the field. Through the data of the second survey the two-body problem (relocation for spouse or partner and limited career options due to the constraints of the career of the partner) and problems related to changes of the PhD supervisor were identified as main factors making it more likely to work outside the field. The completion of a post doc was identified as the main factor influencing the retention of PhD graduates, so that these people were more likely to stay in the field of astronomy and physics. Although there is no direct effect of being female on working outside the field other indirect effects of gender could be identified in the study. Women are more likely to leave astronomy as they are more likely to report less than satisfactory relations with their supervisors and they more often report two-body problems related to the need to find two jobs in the same geographical area for a spouse or partner. In the third survey the reasons for good advising relationships were investigated. The most important factor that contributes to a good advisor relationship is the encouragement of the graduate students by the supervisor to attain their individual goals. Also here an indirect gender effect could be observed: women report less often that they were encouraged to attain their individually set goals by their advisors. Therefore the presentation concluded that although no direct effect of gender could be observed in the data, women are indirectly more likely to work outside the field of astronomy and physics.

Panel Discussion (moderated by Anita Zieher):

"Where have all the women gone? How to promote gender equality in physics?"

- **Ulrike Diebold**, Deputy Head, Institute for Applied Physics, TU Wien
- **Rainer Blatt**, Managing and Research Director, Institute for Quantum Optics and Quantum Information, ÖAW
- **Joachim Burgdörfer**, Dean of Faculty of Physics, TU Wien
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In the course of several rounds of discussion it became obvious that the situation has changed in Austria within the last 30 years. The number of women has increased from 5% to 25% these days. Nevertheless there is evidence for the leaky pipeline phenomenon and also a high fluctuation in terms of yearly entrance numbers of students as the example of the University of Innsbruck shows.

Also at the TU Wien it is evident that the fraction of incoming female students is low (20%). The number of female professors that were hired during the last years has helped to improve the working and research culture at this university. The working and studying climate 25 years back was described in a way that female students had to be outstanding to become noticed due to their minority status in university courses. Furthermore, one participant reported an important observation she has made in the course of her career: to retain women in physics research groups it is necessary to have at least a small group of women which in consequence will not feel as tokens or outsiders and furthermore the culture and group dynamics change. Starting from this nucleus of women more women can be attracted to the group and retained.

The gender experts claimed that there has to be an understanding that it is not only the number of students that is too low if it is only 20-25%, but also the working culture and group dynamics within a physics department might discourage female students but also researchers. Additional important factors are the following: the amounts of resources spent, the number of role models, the vertical segregation at the university, a critical mass of female students, and the way of teaching and advising students. These were considered as important factors to raise the number of incoming students and female researchers within these research groups or institutes.

Ongoing cohort studies at the TU Wien find that the incoming female students that pass the courses of the first semester most likely make their way through the studies and finish their first degree (Bachelor). So the university definitely has to work on the number of incoming female students.

In most issues discussed an agreement between the panel members was visible. But there was one issue which was discussed very controversially: this was meritocracy. Some panel members formulated that meritocracy is the

main principle of science and therefore women need to work hard and focus on their careers to be successful in physics. Other panel members opposed this view by referring to studies of implicit bias against women[1] which undermine their efforts and commitment because they are perceived as less excellent and less committed to their careers. This discussion made evident that a common understanding for the reasons of the underrepresentation of women is still lacking. But such an understanding is necessary to formulate objectives and policies to promote gender equality in physics.

Finally the participants in the panel discussion conveyed to the following recommendations:

- It would be useful to generate more data to understand the main influencing factors inhibiting the participation and the career progress of women even better:
  - Which are the bottlenecks for the career development of female researchers? What are the necessary conditions to facilitate career progress and success of female researchers?
  - Why do students leave and resign from university or do not finish their bachelor or master degree?
- Awareness raising in elementary and high schools would help improving the image of a scientist and especially of a physicist. This should be ideally supported by the participation of female researchers acting as role models for female and male pupils.
- Educational structures have to be improved at the student and university professor level:
  - Students are better trained to do tests than to do novel and original research.
  - University professors need to improve their ability to advise students; most of them are trained to do research but have little experience in advising students during their research phase.
- Continue awareness raising activities by means of target quota like for example within funding programmes such as the special research programmes of the FWF. This measure helped to raise the awareness for women researchers who have the skills and experience to work in or to lead such prestigious research projects.
- Restructure hiring procedures at the research organisations in Austria to enable researcher to get a permanent position earlier in their career; this would slow down the rush hour of life and reduce the long periods of instability and uncertainty of research careers.
- Avoid situations which produce an imbalance of power between female students and male advisors which might lead to situations of sexual harassment. Take a clear and open position against any form of sexual harassment so that everybody is aware that this type of behaviour has no legitimacy within the institution.

[1] For a list of studies on implicit gender bias see: http://www.scienceeurope.org/wp-content/uploads/2017/01/SE_Gender_Practical-Guide.pdf

Lessons learned by the organizers:

- Society has to understand that it is necessary to lower the entrance barrier by means of information transfer to pupils and parents.
- It is necessary to develop a monitoring system to observe various stages of the research career in terms of fluctuation and reasoning for entrance and exit.
- A monitoring and evaluation system for advising and teaching of students is needed.
- We need a programme for promoting female early career researcher and affirmative actions to support this group.
- Awareness about how advisors can encourage women students and early career researchers to continue a research career must be raised.
- More knowledge about discriminatory practices is required.
- Mentoring and leadership programme that includes the gender perspective should be implemented.
- The awareness of the prevalence and of the effects of implicit bias needs to be raised.

The GENERA project

Thomas Berghöfer

Project Coordinator

Deutsches Elektronen Synchrotron DESY • Hamburg

Austrian Gender in Physics Day • May 24, 2017 • Vienna

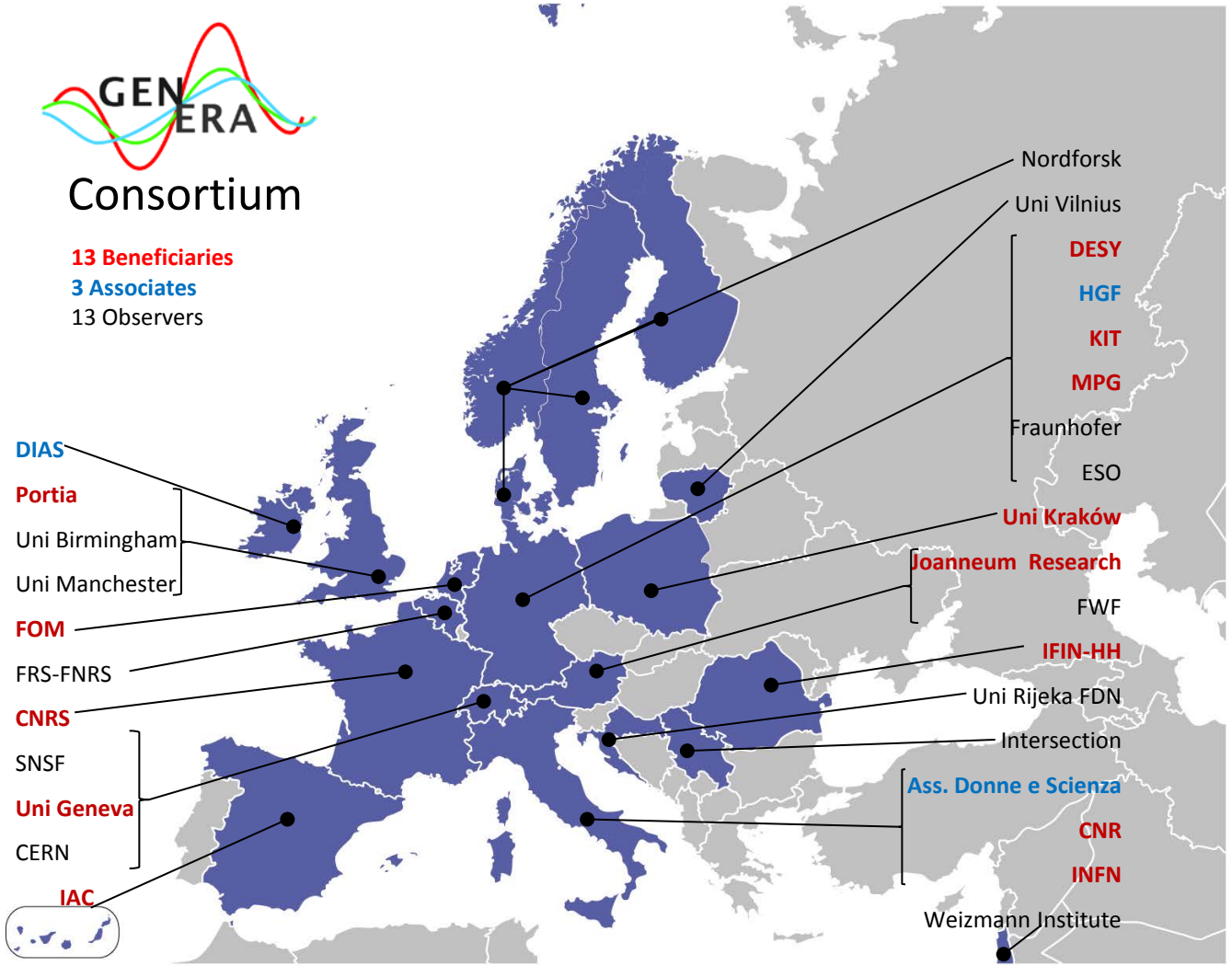
GENERA objectives

- **Assess the status of gender issues** in the partner organisations.
- **Identify gaps in existing GEPs** and **determine specific needs or actions to enhance gender equality and women careers in physics**.
- **Monitor and evaluate the existing activities** of the involved organisations.
- **Formulate customized GEPs** for all implementing organizations and **create a roadmap for implementation of the GEPs in physics** with the potential of application in other research fields.
- **Support involved organisations in implementing customized GEPs**.
- **Create a network** of RPOs, HEIs and RFOs **to promote gender equality in physics.**
- **Set up a long-term monitoring system** allowing RPOs and RFOs monitoring the impact of their GEPs in physics with the potential of application in other research fields.

EU: support systemic institutional changes

Consortium

13 Beneficiaries
3 Associates
13 Observers



Toolbox, roadmap, ...

– what can GENERA offer?

Toolbox

- Started with 65 measures to improve gender equality in physics
- More to come (e.g., support culture of mixed teams, engaging leadership, active scouting in recruitment, ...)

Roadmap

- Describes the implementation process step by step
- Serves as guidebook for implementations managers

Tools for measuring and monitoring

Standards

What is ...
a network of research organisations in physics

- **Framework**
  - to continue with the activities of the GENERA beyond project lifetime
  - to establish a long-term monitoring of the implemented measures and GEPs
  - to enable a support and exchange of experience with other physics related institutions in Europe and beyond
  - to initiate joint actions to commonly improve on gender equality
- **Marketplace for innovative ideas**
- **Commitment**
  - to set standards and comply to them
- **Temptation**

Gender in Physics?

Tomas Brage
Professor and Director of Education in Physics
Lund university, Sweden
Email: tomas.brage@fysik.lu.se

Physics and Gender?

Physics is considered to be objective – not affected by the sex or gender or … of the people involved (researcher, teacher, student …)

… but ….

Physics class-rooms, labs and/or history are extremely affected by sex or gender – often dominated by men

… seems like a contradiction …

Physicist and Gender?

The Physicist looks out in the universe and wonders why there is only matter and no antimatter.

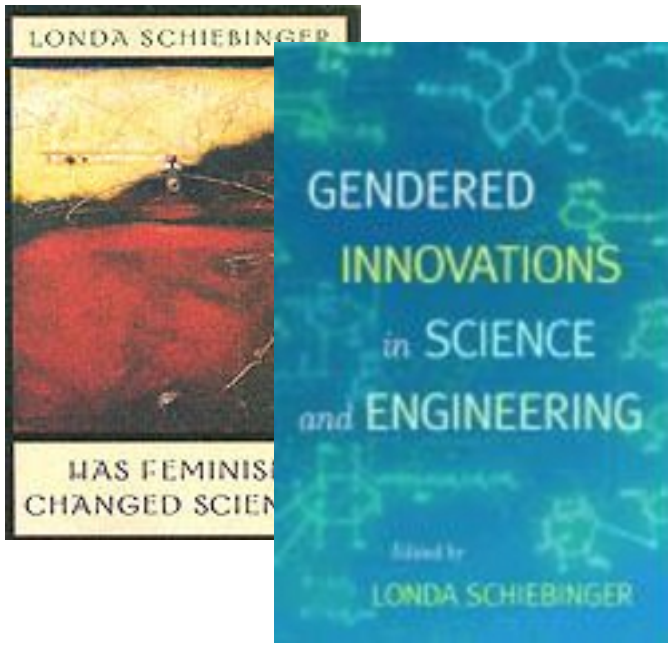
Where did the antimatter go? Is one of the most prestigious questions in Science and the subject of thorough research.

The Physicist looks out over the classroom or lab or history and notes that it is dominated by men.

Where did the women go? Is often a non-question for Physicists and sometimes answered without scientific discussion or method.

Basic model – Levels of Change

Londa Schiebinger, Stanford University



1. Numbers

2. Culture

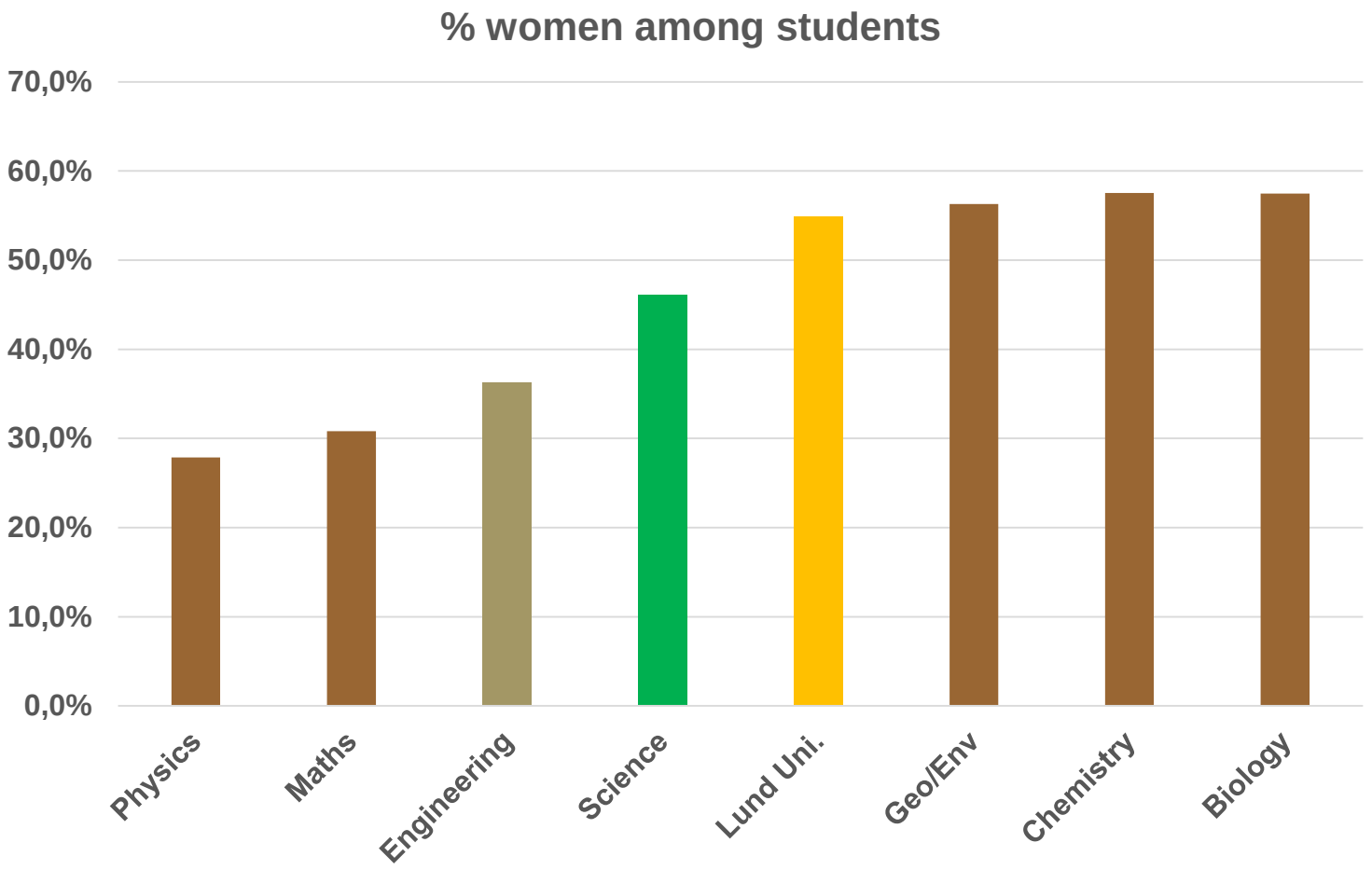
   Gender awareness

3. Subject

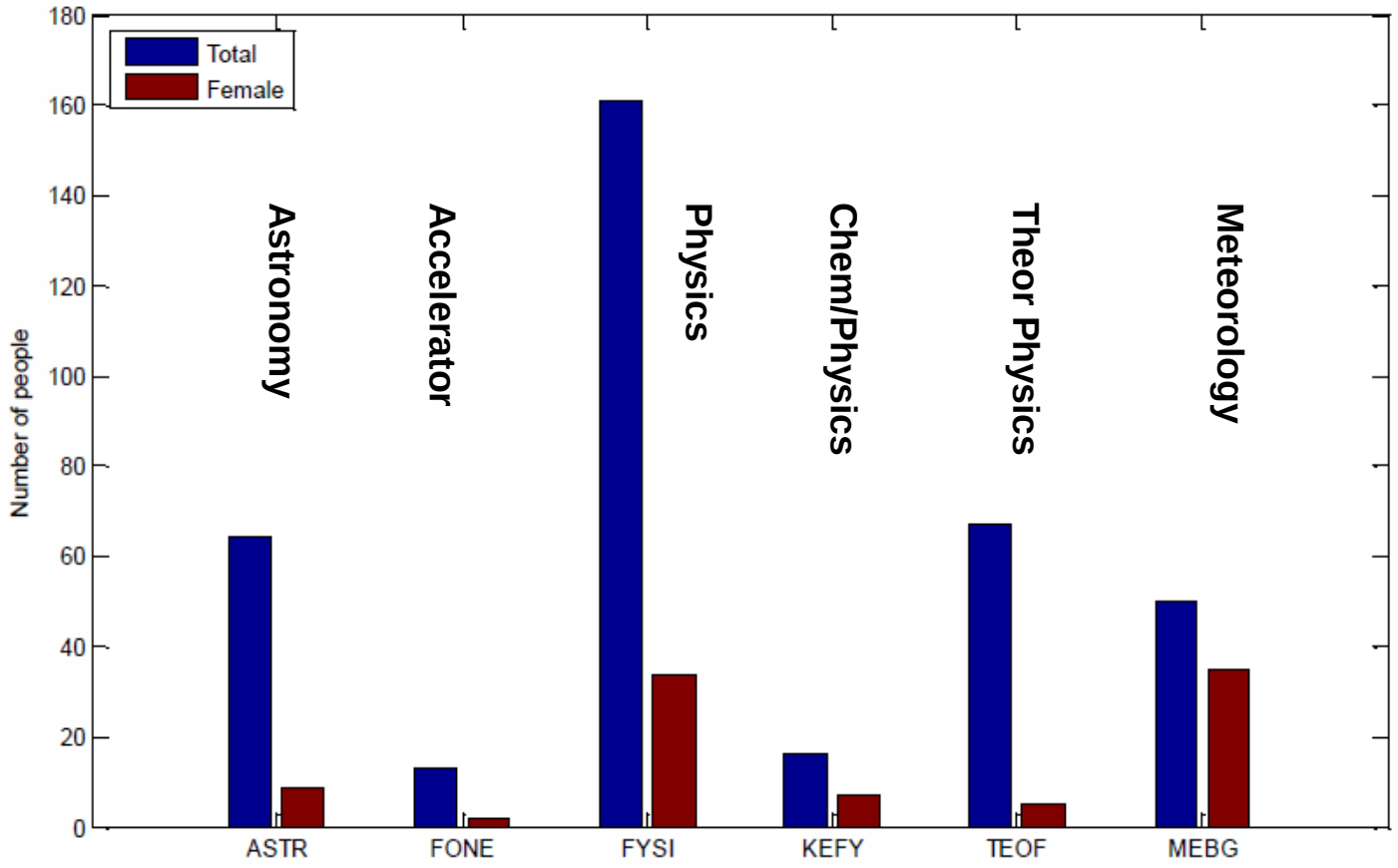
   Gender perspective

Level 1: Numbers

Numbers – Horisontal segregation of Science in Lund

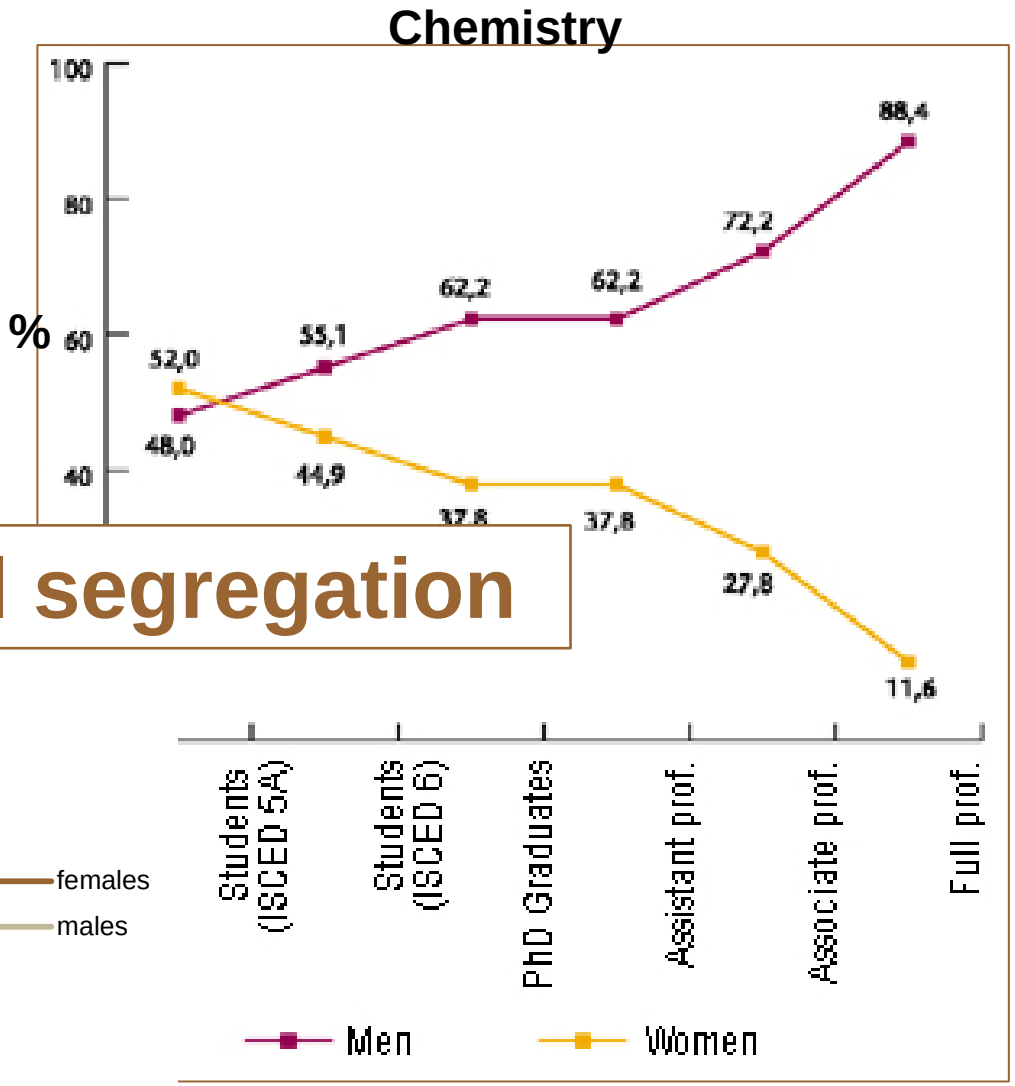


Numbers – Horisontal segregation of Physics in Lund

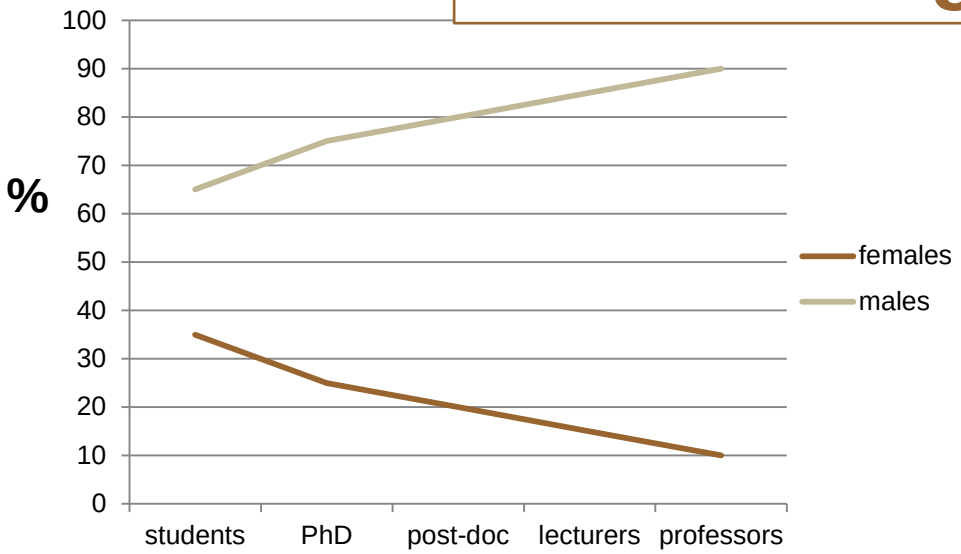


Numbers -

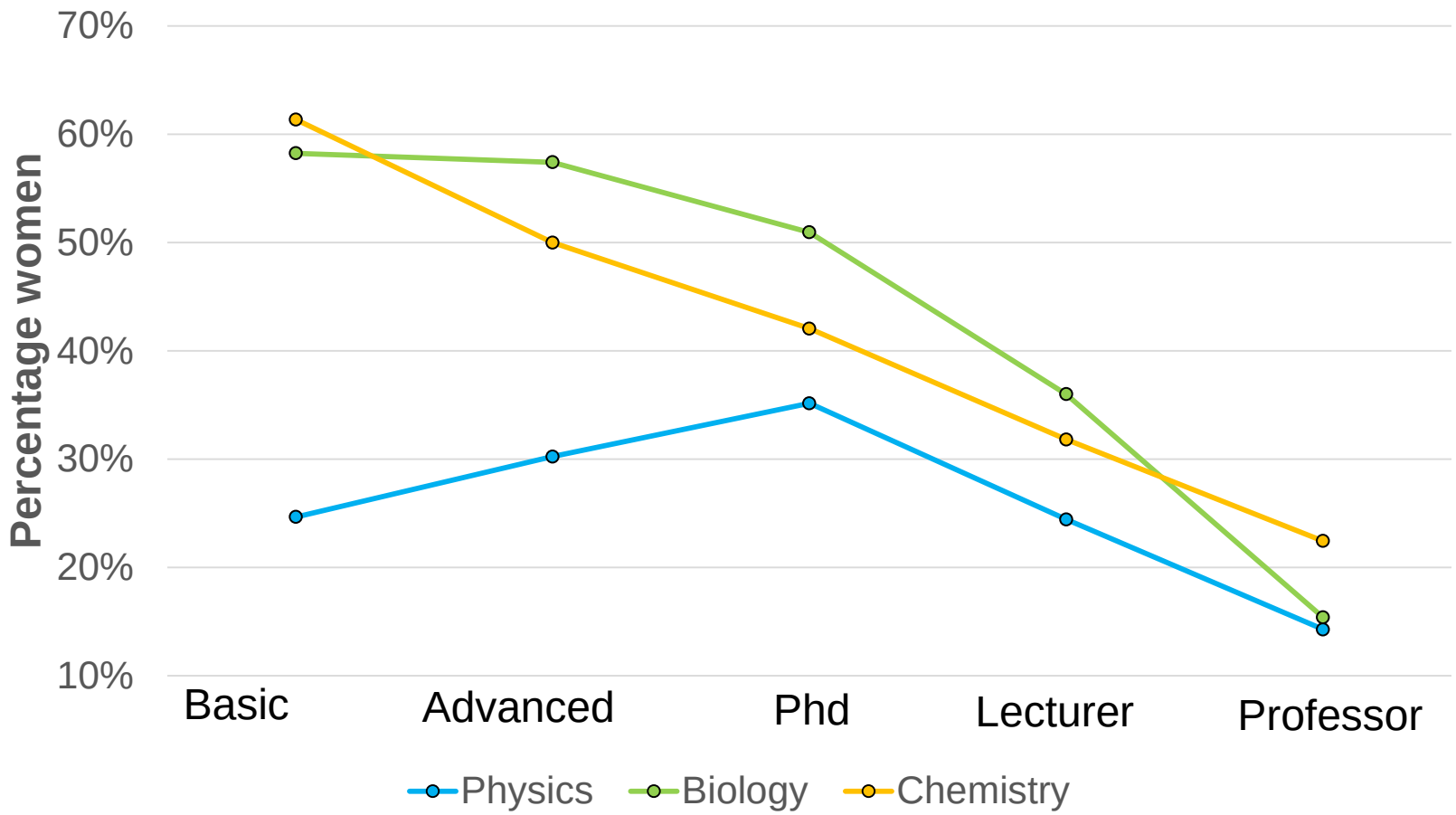
The scissors diagram



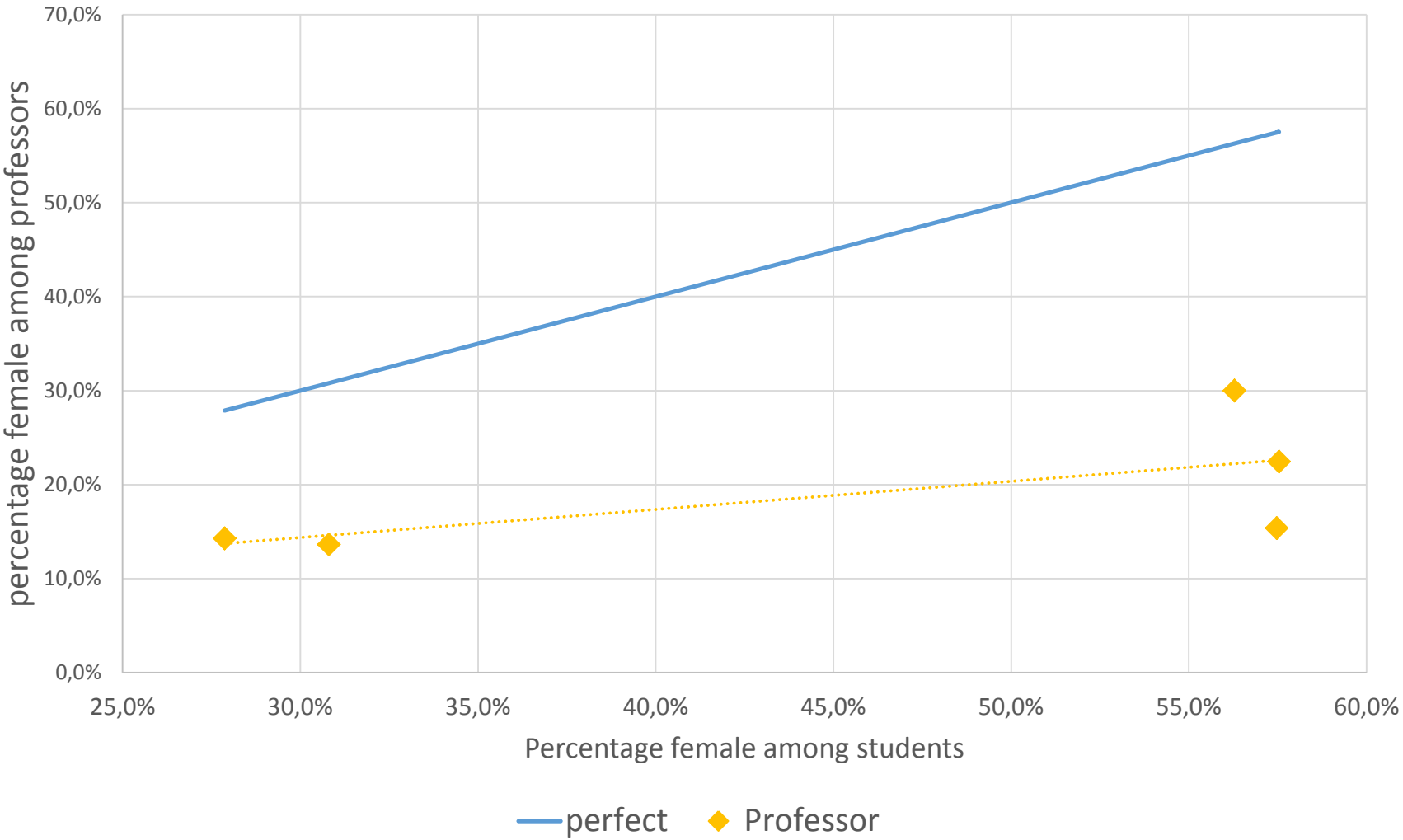
Vertical segregation



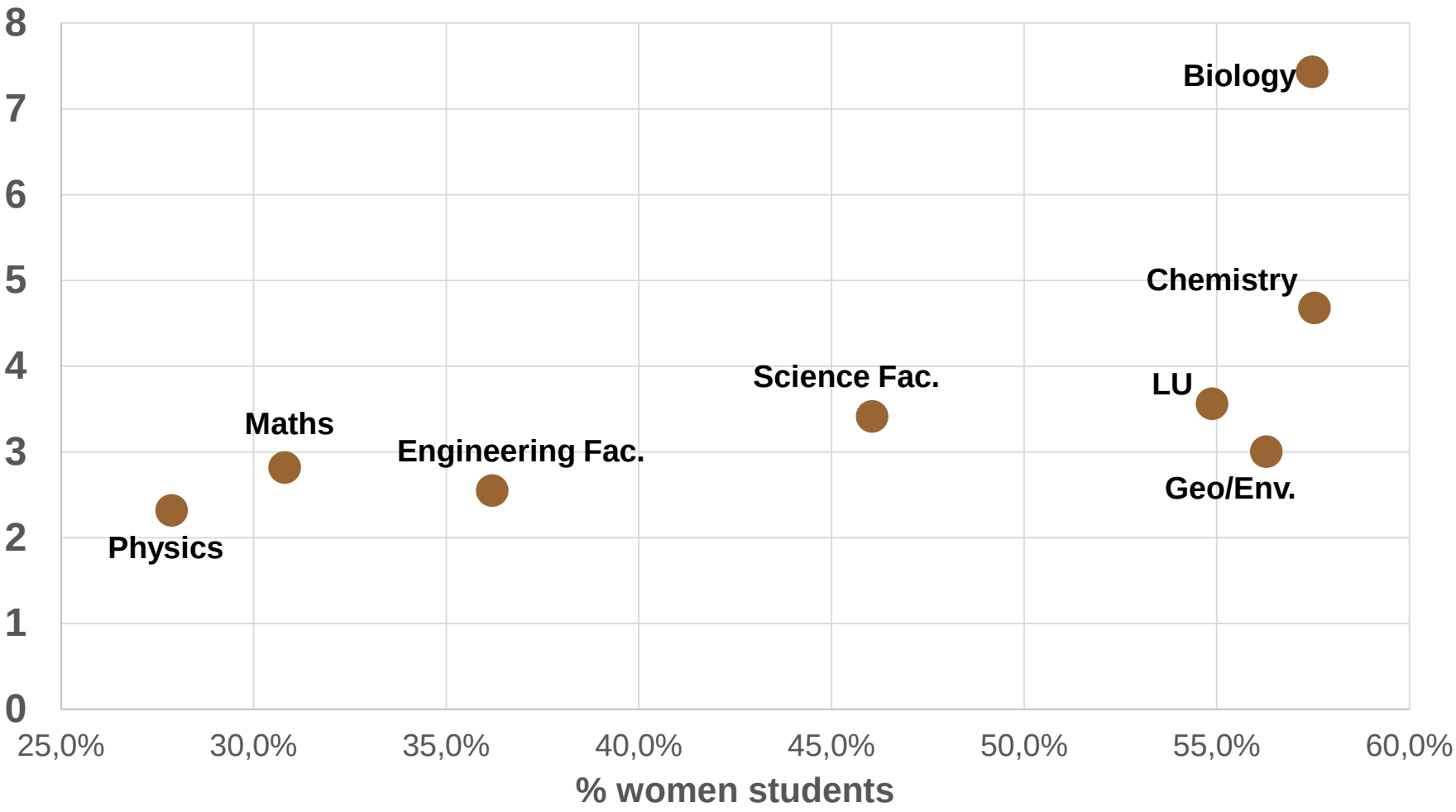
Vertical segregation of Science in Lund



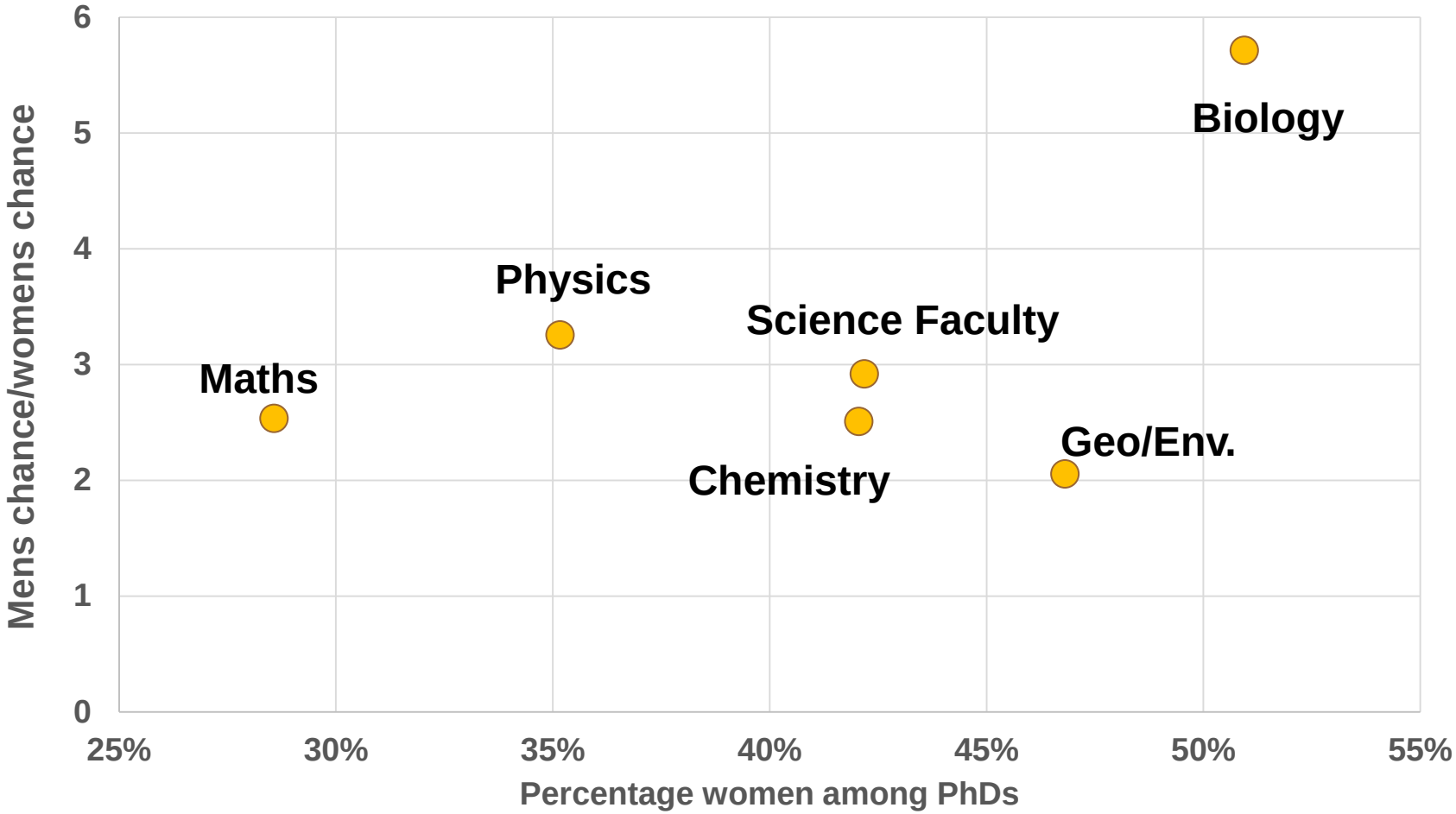
Is recruiting students the solution?



The ratio of men student's to women student's chance to become a Professor.



The ratio of men PhD's to women PhD's chance to become a Professor.



Vertical segregation – explanations

From the leaky pipeline …

…. to the vanishing box

Etzkowitz and Ranga 2011 *Gender Dynamics in Science and Technology ...,* Brussels Economic Review

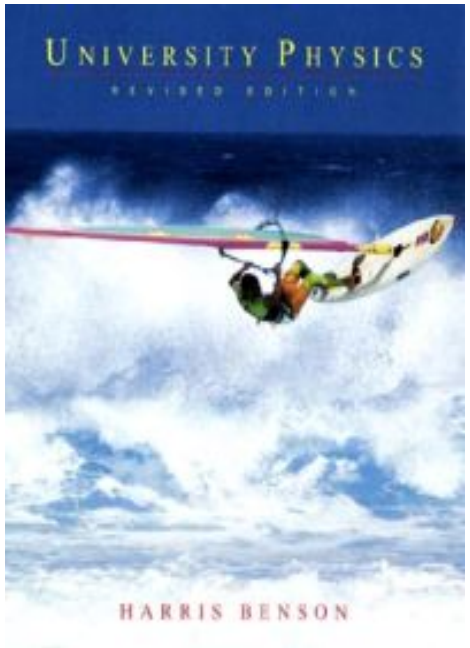
Conclusion 1

- The vertical segregation is there in all subjects – but its strength depends on the institution.

- It's about ***the culture*** **of at our institutions**!

Level 2: ”Culture”:
- stereotypes, attitudes ...

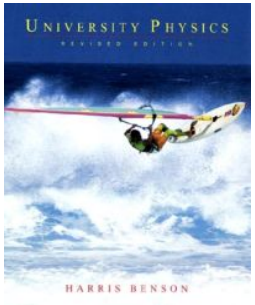
Culture – visual presentations in textbooks



Calculus based, introductory books

- Benson, University Physics
  - Traditional book

Culture – visual presentations



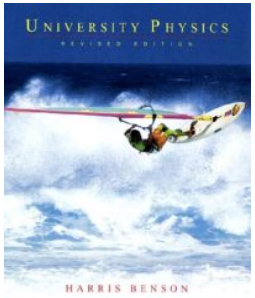
Benson

23. What arrangement of mirrors would produce the multiple images of Ann Margaret shown in Fig. 35.51?

FIGURE 35.51

Culture – visual presentations

Pictures of women

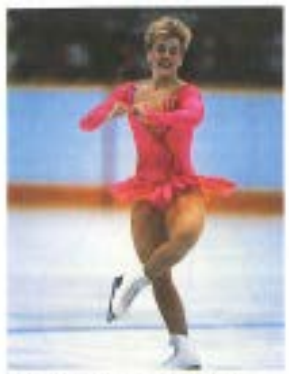


Benson

What do you notice about the front wheel?

The net work done on the javelin is equal to the change in its kinetic energy.

During a grand jeté, a ballet dancer appears briefly to "float in air". However, the center of mass still follows a parabolic path.



Elizabeth Manley controls her angular speed by varying her moment of inertia.

Culture – visual presentations

Pictures of men

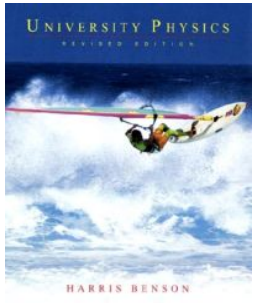


FIGURE 9.1 René Descartes (1596–1650).

FIGURE 1.8 Johannes Kepler (1571–1630).

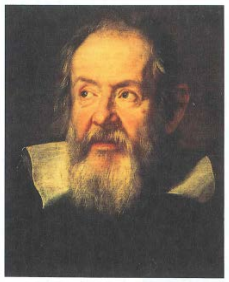


FIGURE 1.9 Galileo Galilei (1564–1642).

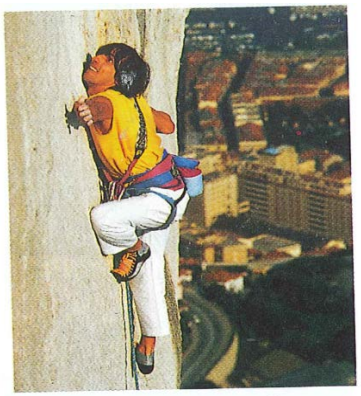
FIGURE 5.1 Sir Isaac Newton (1642–1727).

FIGURE 8.2 Gottfried W. Leibniz (1646–1716).

(b)

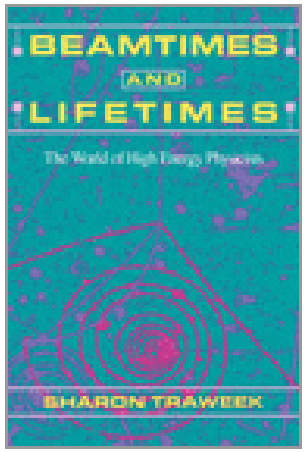
Although the mass of Edwin Aldrin, Jr., had not changed, his weight on the moon was roughly one-sixth his weight on earth.

A weightlifter does work to lift weights but not to hold them at rest.



The climber has done work to increase his potential energy.

A classic about culture of Physics – Anthropology



Sharon*Traweek – Beamtimes and Lifetimes*

Physicists assume that we have a culture without culture

Investigations of SLAC (USA) and KEK (Japan)

Different definition of excellence and leadarship

....but what is male, defines excellence

Culture – history of Physics

- Often incorrectly described in books

"The Development of Quantum Physics, in Historic Accounts, Textbooks and Classrooms"

Reidun Renstrøm, Agder Universitet in Norway

Culture - Sociology:

Hasse and Trentemoller: UPGEM-project (2008)

UPGEM
Understanding Puzzles in the Gendered European Map

What is the percentage of women among Physics professors?
Denmark, Estonia, Finland, Italy, Poland

Which has the largest percentage?

Which has the smallest percentage?

Culture - Sociology:

Hasse and Trentemoller: UPGEM-project (2008)

UPGEM
Understanding Puzzles in the Gendered European Map

What is the percentage of women among Physics professors?
Denmark, Estonia, Finland, Italy, Poland

Denmark – 3%
Estonia – 11%
Finland – 12%
Poland – 14%
Italy – 23%

Is it Physics in culture?

Using ”Culture Contrasts” to understand:

Is it Physics in Culture – outside Physics?

1. The Classically schooled Physicist
2. Family culture
   a) Parenthood contra motherhood
   b) Child care contra nannies
   c) Nuclear contra extended family
   d) Strong border between family and work?

      What about flexibility?
3. Religion

Denmark – 3%
Estonia – 11%
Finland – 12%
Poland – 14%
Italy – 23%

... Or is it Physics as culture?

Three cultures ”discovered”:

1. Hercules-culture – the fighter’s culture
2. Care taker-culture – the social culture
3. Working bee-culture – the industrious culture

Denmark – 3%
Estonia – 11%
Finland – 12%
Poland – 14%
Italy – 23%

Hercules:

Oh yes, there is a lot of competition. This whole process is extremely competitive. The case that the department needs to make to the university is that I am not only good enough for the job, but I am the best person in the world for this job.

Care-taker:

There's always a team behind a genius. (...) Good teamwork always brings the best results, but of course, not everyone is lucky enough to find a good group to work with. Sometimes when there are very competitive people, it is difficult to form a group..

Working bee:

But in this respect, for us not to show ourselves too much and do no crazy things, we had to sit quiet and pretend we were not there

Investigation of five countries:

Denmark, Finland, Estonia, Poland and Italy

What culture defines Physics departments in the different countries?

Denmark – 3% - Hercules

Estonia – 11% - Working bee

Poland – 14% - Working bee

Italy – 23% - Care-taker

Finland –12% - not a clear culture

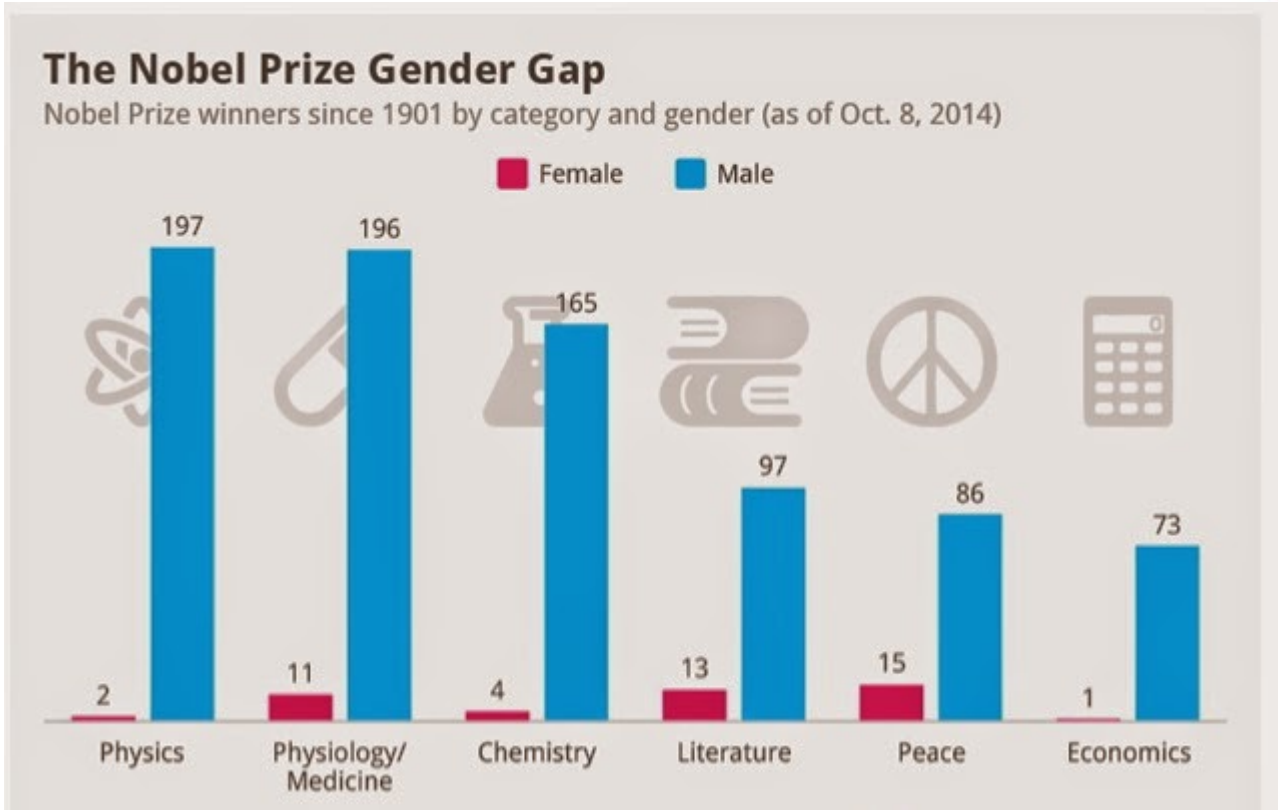
Remember: It is the perception of the culture, but

..... is it really the culture of Physics?

..... and what do they say to their students?

Level 1: Numbers

Vertical Segregation – even higher



Courtesy www.statista.com

Level 2: Culture

Ex 3: Bias

Traditional results – repeated many times:

Judge identical texts, grade 1 (lowest) – 5 (highest):

	Men about		Women about	
	Ingvar (Male)	Ingvor (Female)	Ingvar (Male)	Ingvor (Female)
Credible	4.9	3.4	4.5	3.5
Nonchalant	2.6	2.4	2.7	2.3
Humane	2.9	2.7	3.2	3.8
Competent	4.3	3.0	3.7	3.3

Example of bias against women

- Receive smaller grant allocations
- Worse evaluations of abstracts for conferences
- Fewer citations
- Worse student evaluations
- Men 8 times more likely to win awards (?)
- Fewer leadership positions
- Worse letters of recomendations

Conclusion 2

- We are all suffering from **implicit bias**, which we need to become aware of – education, information, workshops. (https://implicit.harvard.edu/implicit/)

- BUT, this is not enough – we need **”Bias observers”** to remind us during meetings, selection committees etc.

Bias and Meritocracy?

*Nielsen (2015) Nature **525** 427 – Studie vid Aarhus universitet 2004-2013*

Appointment of Professors and Lecturers:

- 20% closed (30% later years)
- 40% only one applicant

Women part of appointed professors:

- Closed: 12%
- Open: 23%

Similar results from Netherlands and Finland

Van den Brink (2010) and Husu (2000)

Meritocracy and Equality?

*Nielsen (2015) Nature **525** 427 – Studie vid Aarhus universitet 2004-2013*

We know we are affected by bias:

This combined with the

Myth of Meritocracy

Creates arguments against change

There is an persistant idea that equal opportunity is contradictory to or counteracts meritocracy

”The university is a realm of the *justly unequal*”

Discr.

Level 2: ”Culture”:
- discrimination and harassment

Ex 1: Dandelion Physicists

- 4 of 14 women avoid being alone with some people at their work.
- 5 of 14 women have some experience of sexual harassment at work.
- 5 of 14 have experiences of sexual harassment at conferences.

Lundborg and Schönning, investigation of PhD-students situation at the Physics Department, Uppsala 2006

Dandelion Physicists

- *Sexual harassment is a non-issue for male PhD-students.*

- *15% of the men said that they"* consciously tried to demean the women*". They did not like the women to advance in the society.*

Lundborg och Schönning, Uppsala 2006

More investigations:

- 53% of female employees have been harrassed on the grounds of their sex – repeatedly ignored, ridiculed, withhold information, made invisible – for men 23% (*Chalmers 2005)*

- 41% of femal staff claim to have experienced some form of sexual violence – for men 26% (*Quebec 2013*)

……..

A repeated pattern of discrimination:

Power ⟶ Suppression techniques

Conclusion 3

- Discrimination and harassment is common and an essential problem to deal with.
- **Introduce anti-discrimination measures, through courses or workshops**
- Find out **why people leave**

Conclusion 4

- Since some people are marginalised and discriminated

  – **introduce Counter-spaces**

  (*Maria Ong and co-workers*)

concl

”Higher-order effects”

Ex: Parental leave in Sweden – a success-story?

0th-order: Parenthood = Motherhood

Need to include fathers!

1st-order: Parental leave follows child (in Sweden 16 months)

…..but…..

- Only 24% of time taken by dads – in spite of 2 months devoted ”Father leave”
- women stack there parental leave – women get behind in career.

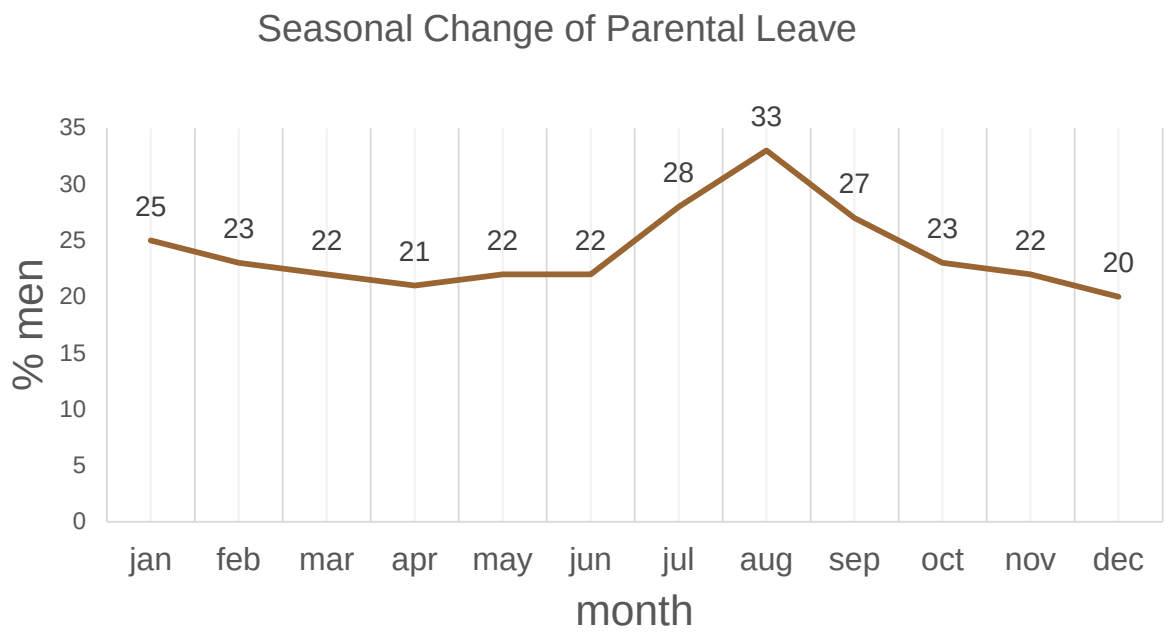
Need to individualize parental leave?

”Higher-order effects”

Ex: Parental leave in Sweden

2nd-order: Individualized Parental leave – equal shares

…but..... Seasonal variations:



”Higher-order effects”

Ex: Parental leave in Sweden

2nd-order: Individualized Parental leave – equal shares

…but…:

Fathers seems to be punished harder

Legislation is not enough!

We need to change the culture!

Conclusions – Gender and Science

- It is important to move beyond numbers and work on changing the **culture** of Science (and the culture Science is in, of course)
- We are all **bias** – and in Science it works against women.
- Women experience strong **discrimination** based on their gender.
- Bias is a threat to true **meritocracy**.
- Thanks to the research of humanists and social scientists we are getting closer to an understanding of the **segregation** and therefore what to do about it.
- An active, challenging and important field of **research**.

So – what can we do?

1. **Education**, information
2. **Gender-integrated** leadership and carrier planning
3. We are **implicit bias –** we need **bias observers**
4. Discrimination is common – do not only **affirm women**, but also **confine men** – but get them involved – and find out why people leave
5. **Counterspaces**
6. **Awards**/Certification for best practices (e.g. Athena Swan or Gender certification)

But it is not easy ....

Thank you for your attention!

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See WG Gender's "papers":

- *Women, universities an research: excellence without gender bias*, 2012
- *Gendered research and innovation: Integrating sex and gender analysis into the research process,* 2015
- *Implicit bias and the threat to Meritocracy,* coming 2017.

WOMEN'S AND MEN'S CAREER CHOICES IN ASTRONOMY AND ASTROPHYSICS

Rachel Ivie

Supported by US National Science Foundation

LONGITUDINAL STUDY OF ASTRONOMY GRADUATE STUDENTS

- Partnership between American Institute of Physics and American Astronomical Society (AAS)
- Includes everyone who was in graduate school in astronomy or astrophysics in the US, 2006-07
- Data have been collected from the same cohort of people in order to document individual career paths
- Three waves of data have been collected:
  - 2007-08
  - 2012-13 *five years later*
  - 2015-16 *eight years later*

THIS ANALYSIS

- Second and third surveys
- limited to people who
  - completed PhDs at the time of the 2nd survey
  - were not postdocs at the time of the surveys

LONGITUDINAL STUDY OF ASTRONOMY GRADUATE STUDENTS

- Result of Women in Astronomy Conference, 2003 in California, USA
- At that time, about 60% of younger members were women, and AAS wanted to know outcomes for these members.
- Would women have a higher attrition rate? Are women more likely to leave the field? If so, why?

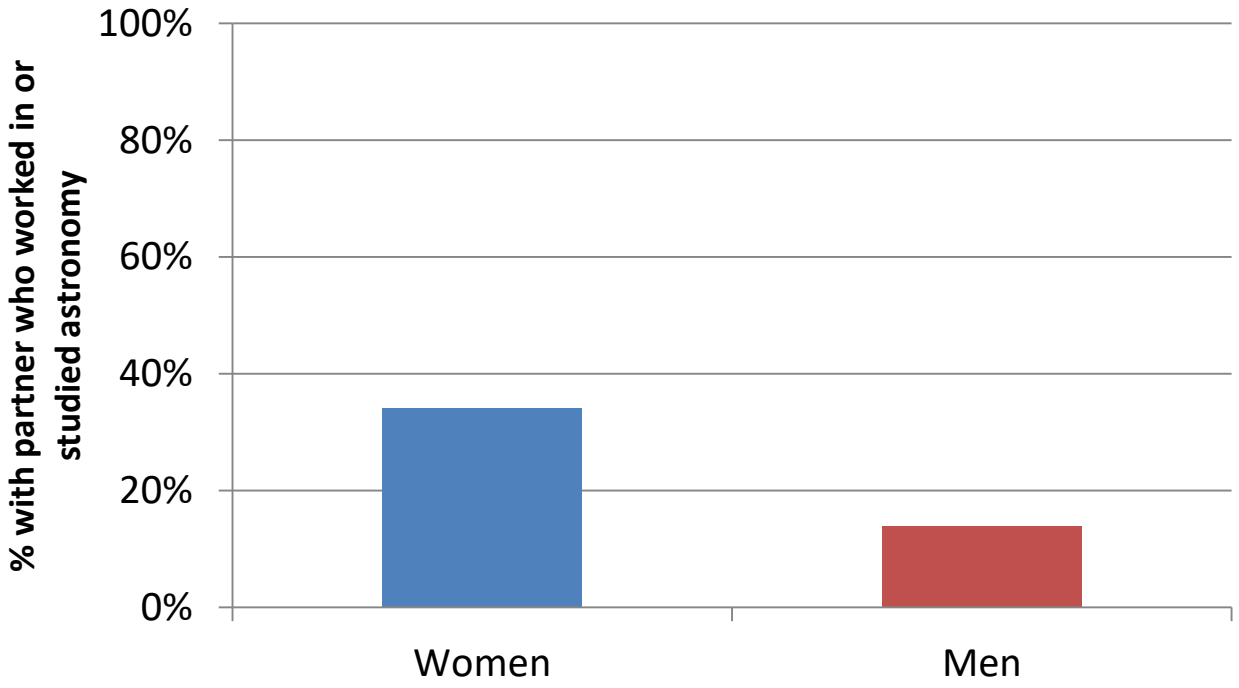
HYPOTHESIS

We hypothesized that women would be more likely to work outside of astronomy and physics. In other words, being female would have a direct effect on leaving the field, independent of other factors.

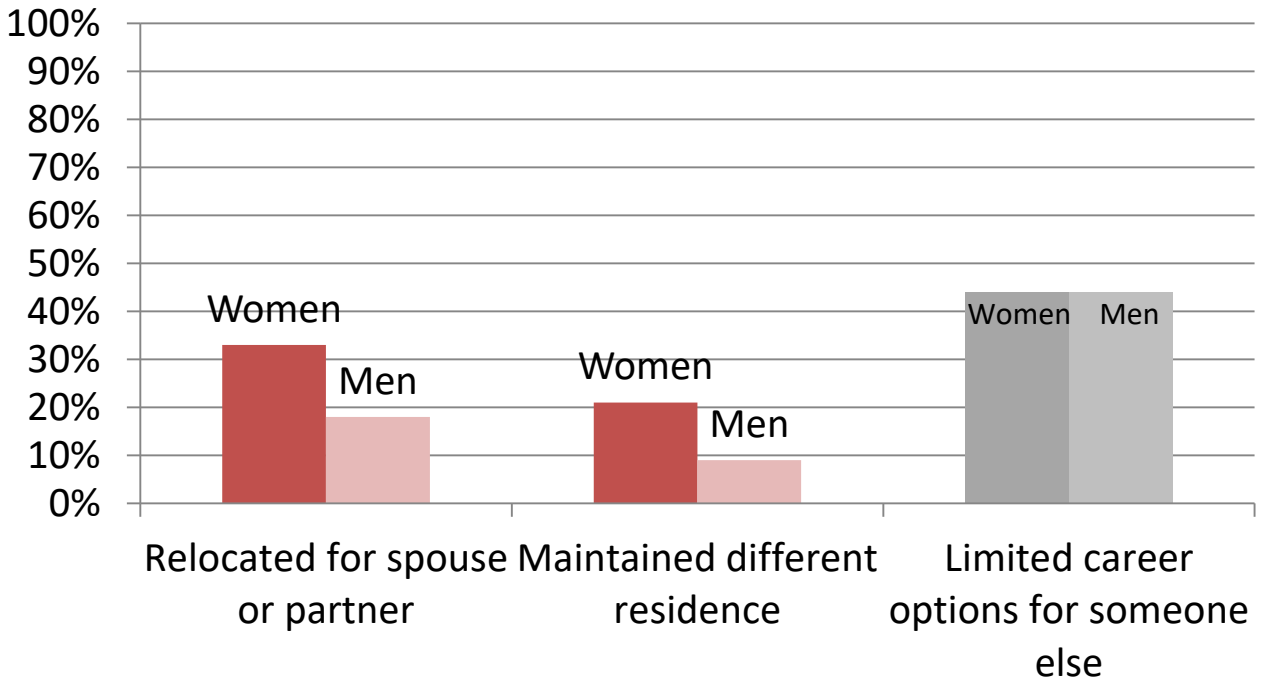
IS WORKING IN OR OUT OF FIELD AFFECTED BY

- Being male or female (40% female respondents)
- Taking a postdoc
- *Two-body problem (a work/family balance problem that refers to the difficulty of finding 2 jobs in same geographic area)*
- *Having a mentor other than advisor*
- *Relationship with advisor*
- *Imposter syndrome (at time of first survey)*
- Time since degree

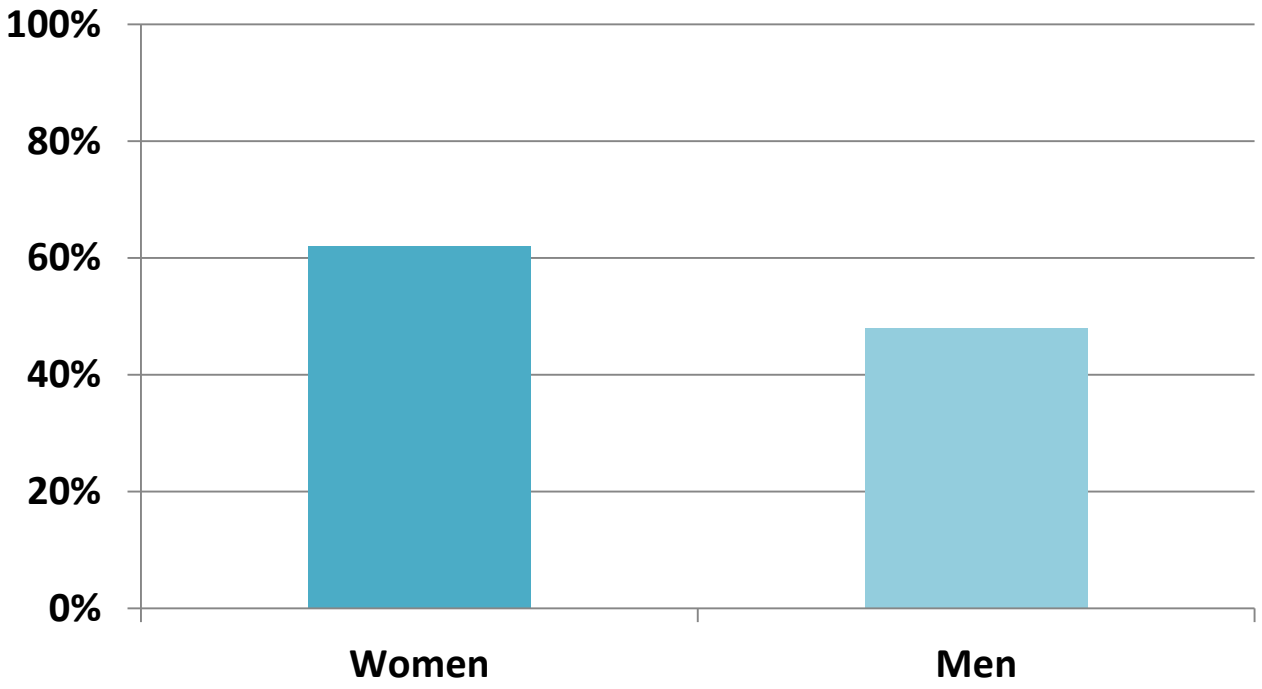
SECOND SURVEY
PARTNER IN ASTRONOMY



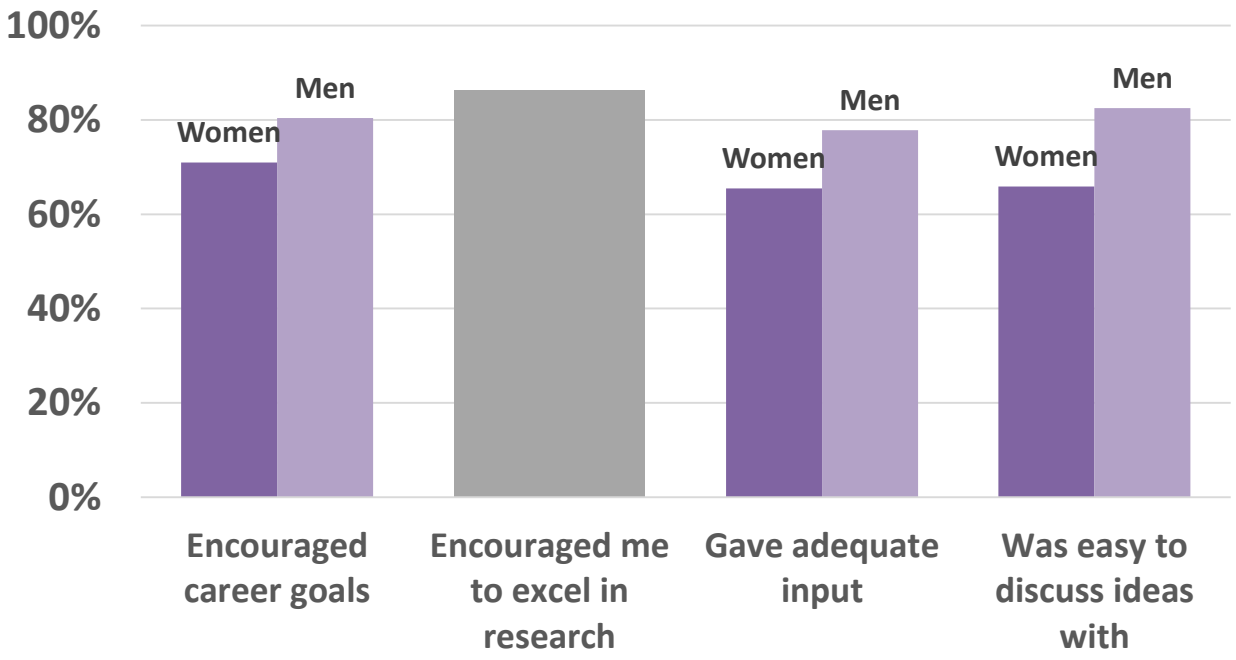
SECOND SURVEY
TWO-BODY PROBLEM



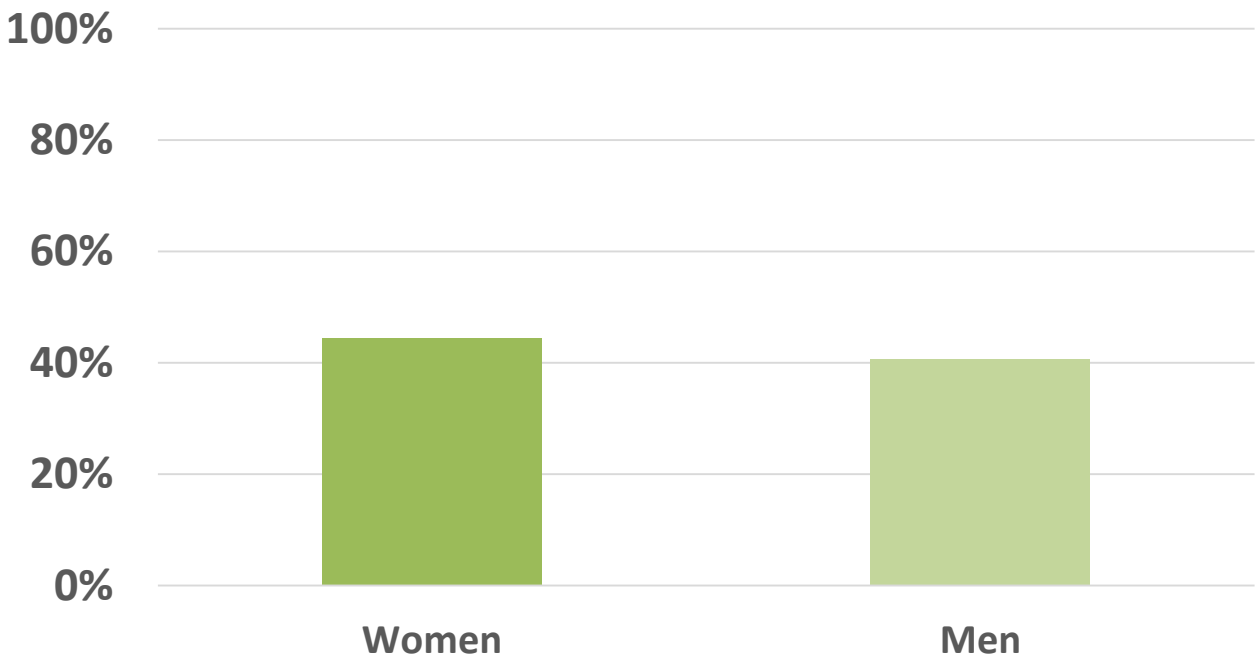
SECOND SURVEY
MENTOR OTHER THAN ADVISOR IN GRAD SCHOOL



SECOND SURVEY
FOUR MEASURES OF ADVISOR RELATIONSHIP



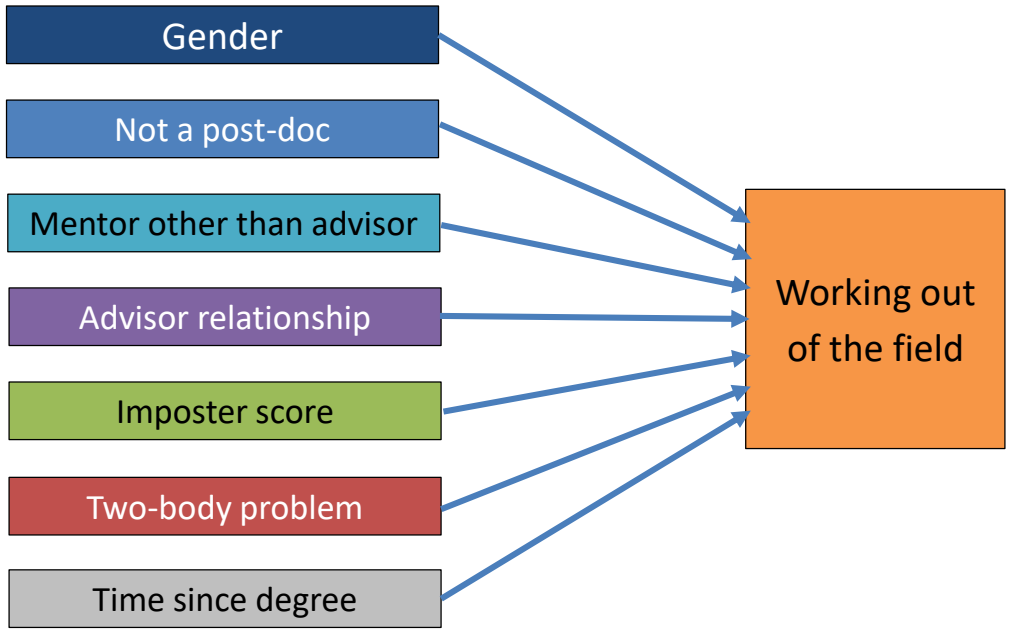
FIRST SURVEY
IMPOSTER SYNDROME



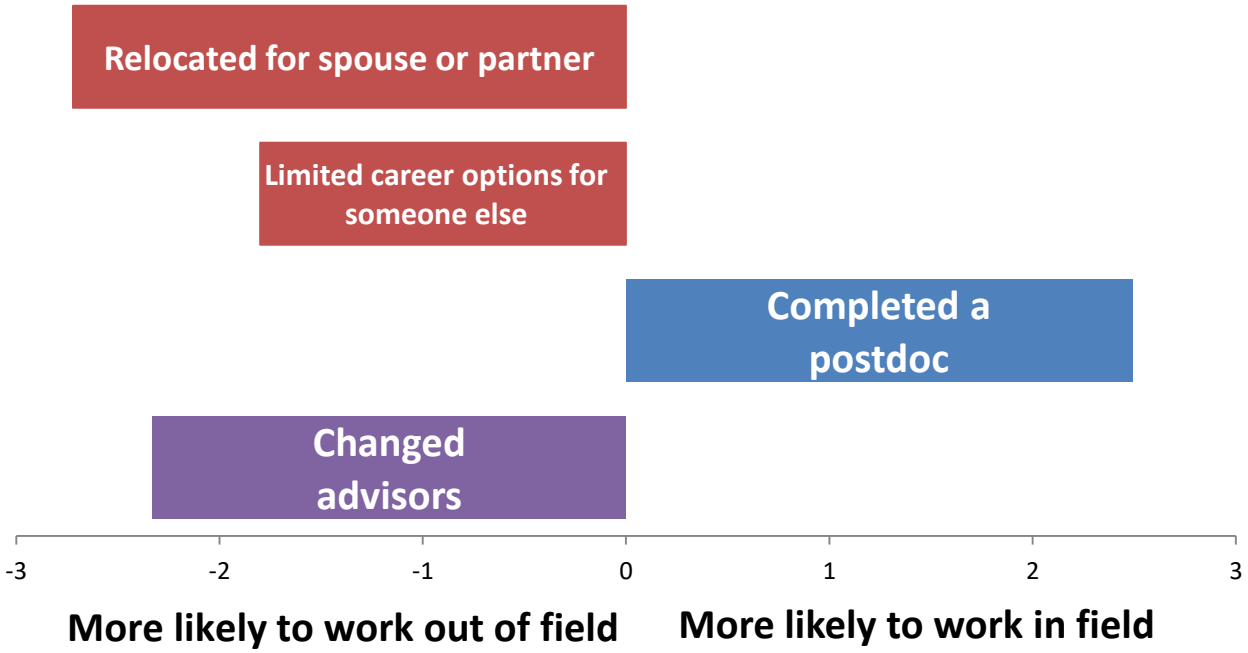
HYPOTHESIS

We hypothesized that women would be more likely to work outside of astronomy and physics. In other words, being female would have a *direct* effect on leaving the field, *independent* of other factors.

SECOND SURVEY
DOES BEING MALE OR FEMALE INDEPENDENTLY AFFECT OTHER VARIABLES IN MODEL?



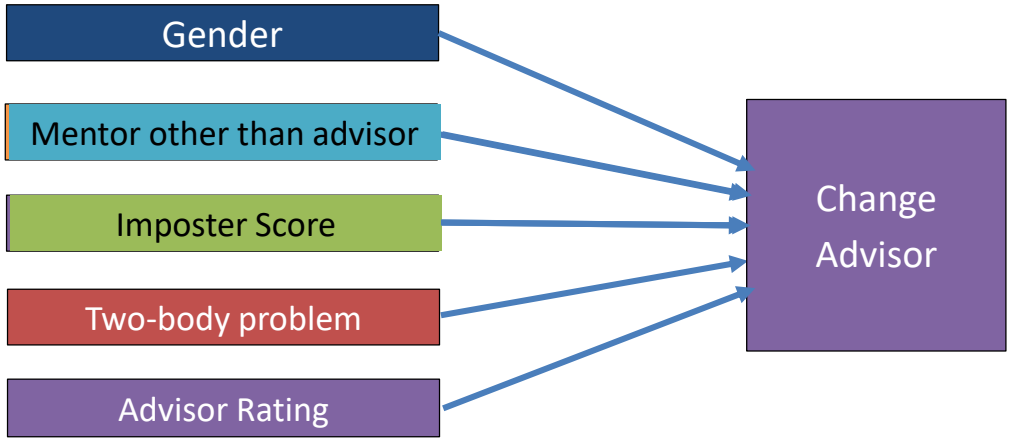
SECOND SURVEY
FACTORS THAT INFLUENCE WORKING OUT OF FIELD



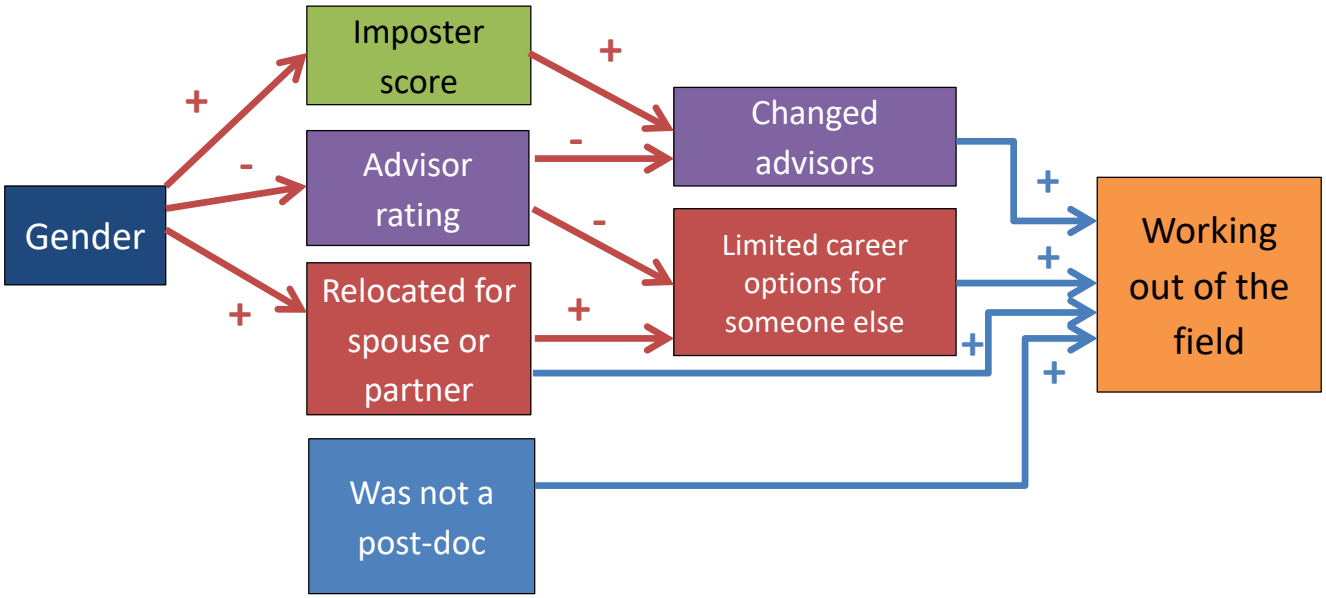
ANOTHER HYPOTHESIS

- There may be indirect effects of gender on working out of field.
- In other words, women may be more likely to have experiences that increase the likelihood of working out of field.

SECOND SURVEY
TESTING INDIRECT EFFECTS OF GENDER
EXAMPLE OF ONE MODEL



SECOND SURVEY
THE INDIRECT EFFECT OF GENDER ON WORKING OUT OF FIELD



CONCLUSIONS FROM SECOND SURVEY

- We hypothesized that women would be more likely to work outside of astronomy and physics. In other words, being female would have a direct effect on leaving the field, independent of other factors.
- However, there is no direct effect of being female on working outside the field. The effect of being female comes through other factors.
- Women may be more likely to leave astronomy because
  - Women are more likely to report less than satisfactory advising.
  - Women are more likely to report two-body problems related to the need to find two jobs in the same geographic area for a spouse or partner.

THIRD SURVEY, 2015

- What is it about the advising relationship that makes a difference?
- The 3rd survey has additional items about the advisor relationship.

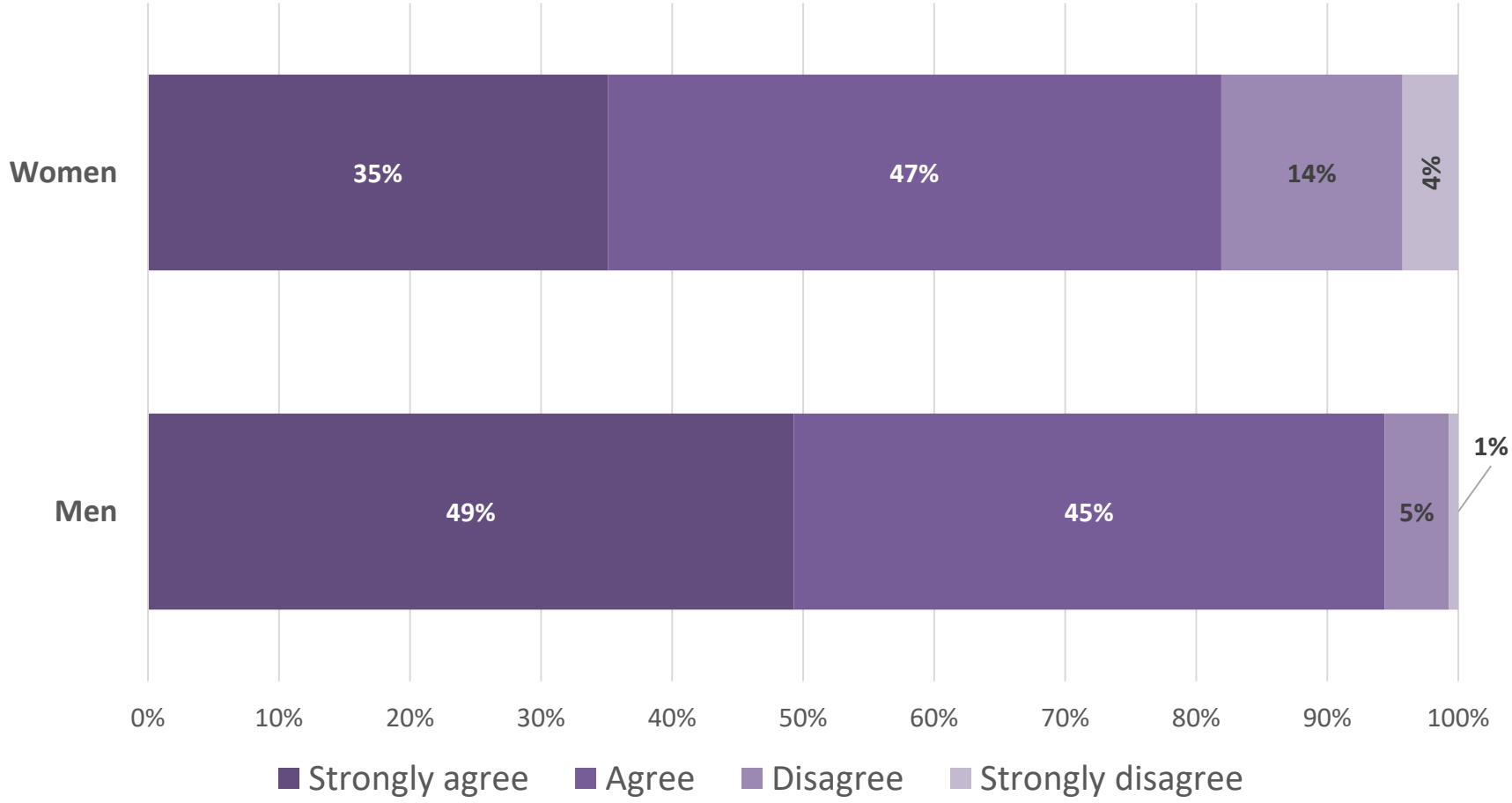
ADVISOR QUESTIONS, THIRD SURVEY (FROM AMERICAN CHEMICAL SOCIETY)

- Encourages me to present our research at scientific conferences
- Gives regular feedback on my research
- Gives the appropriate level of credit to me for my research contributions
- Engages me in writing grant proposals
- Provides information about academic career paths
- Provides information about non-academic career paths

ADVISOR QUESTIONS, THIRD SURVEY (FROM AMERICAN CHEMICAL SOCIETY)

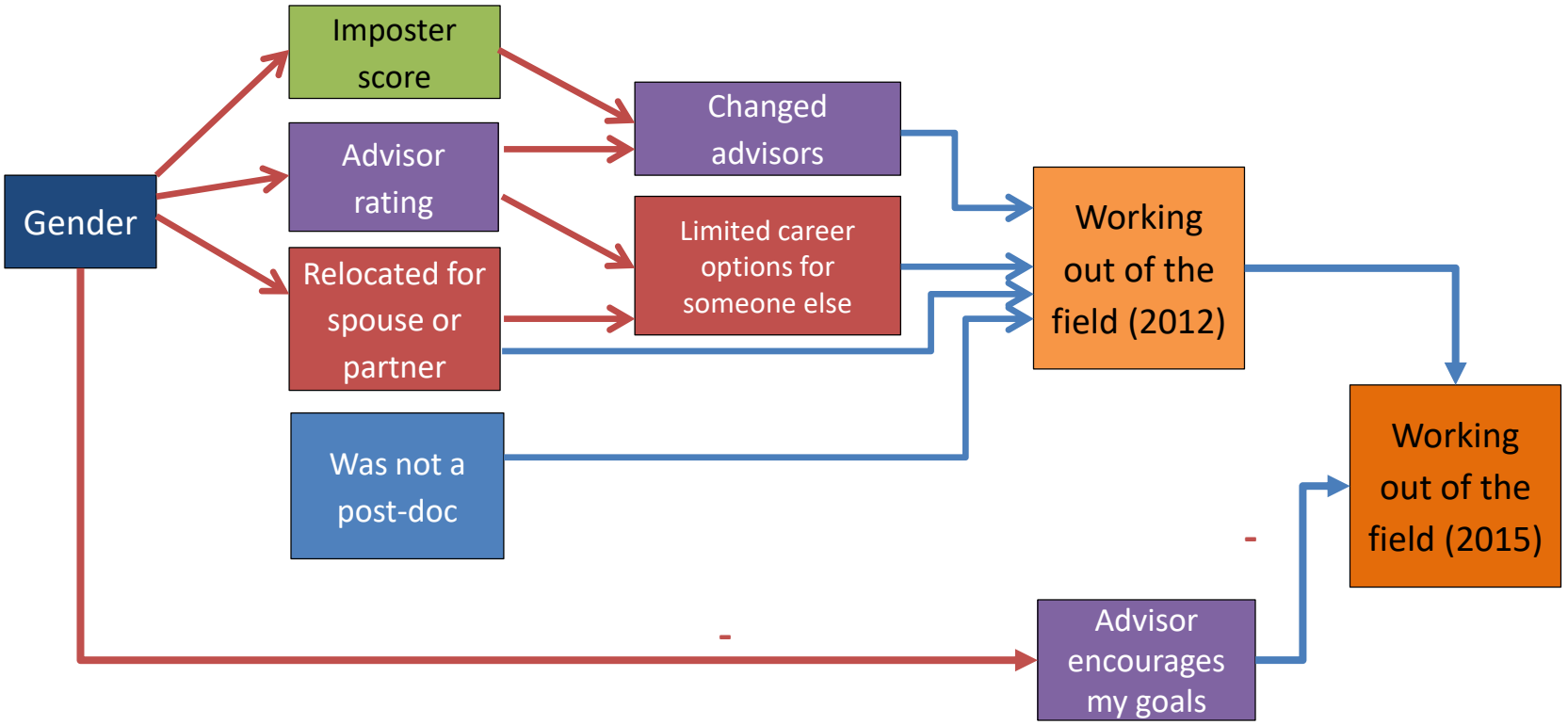
- Helps me to develop professional relationships
- Advocates for me
- Supports my career path of choice
- Models good professional relationships
- Encourages me to attain my goals
- Takes time to learn about my background, interests, and/or personal relationships

THIRD SURVEY
MY ADVISOR ENCOURAGES ME TO ATTAIN MY GOALS



FACTORS DIRECTLY AFFECTING WORKING OUT OF FIELD IN 2015

THE INDIRECT EFFECTS OF GENDER ON WORKING OUT OF FIELD 2012 & 2015



CONCLUSIONS FROM THIRD SURVEY

- There still is no direct effect of being female on working outside the field. The effect of being female comes through other factors.
- The 2015 survey found that the most important predictors of working out of field are
  - Having worked out of field previously
  - Reporting that your advisor did not encourage you to attain your goals
- In addition to the factors that contributed to working out of field in 2012, women may be more likely to leave astronomy because
  - Women are less likely to say that their advisor encouraged them to attain their goals.
  - Women were indirectly more likely to have worked out of field in 2012.

THANKS TO SUSAN WHITE AND RAYMOND CHU

For more information

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OUTCOMES OF THOSE WITH PHDS, 2012-13