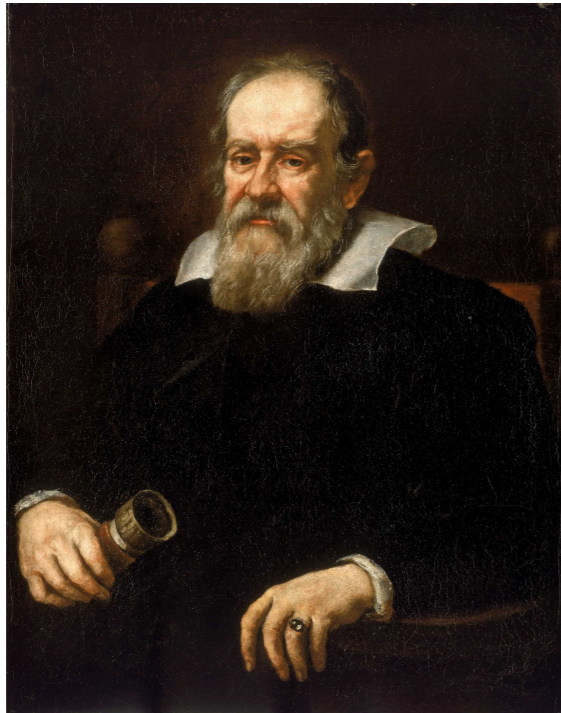


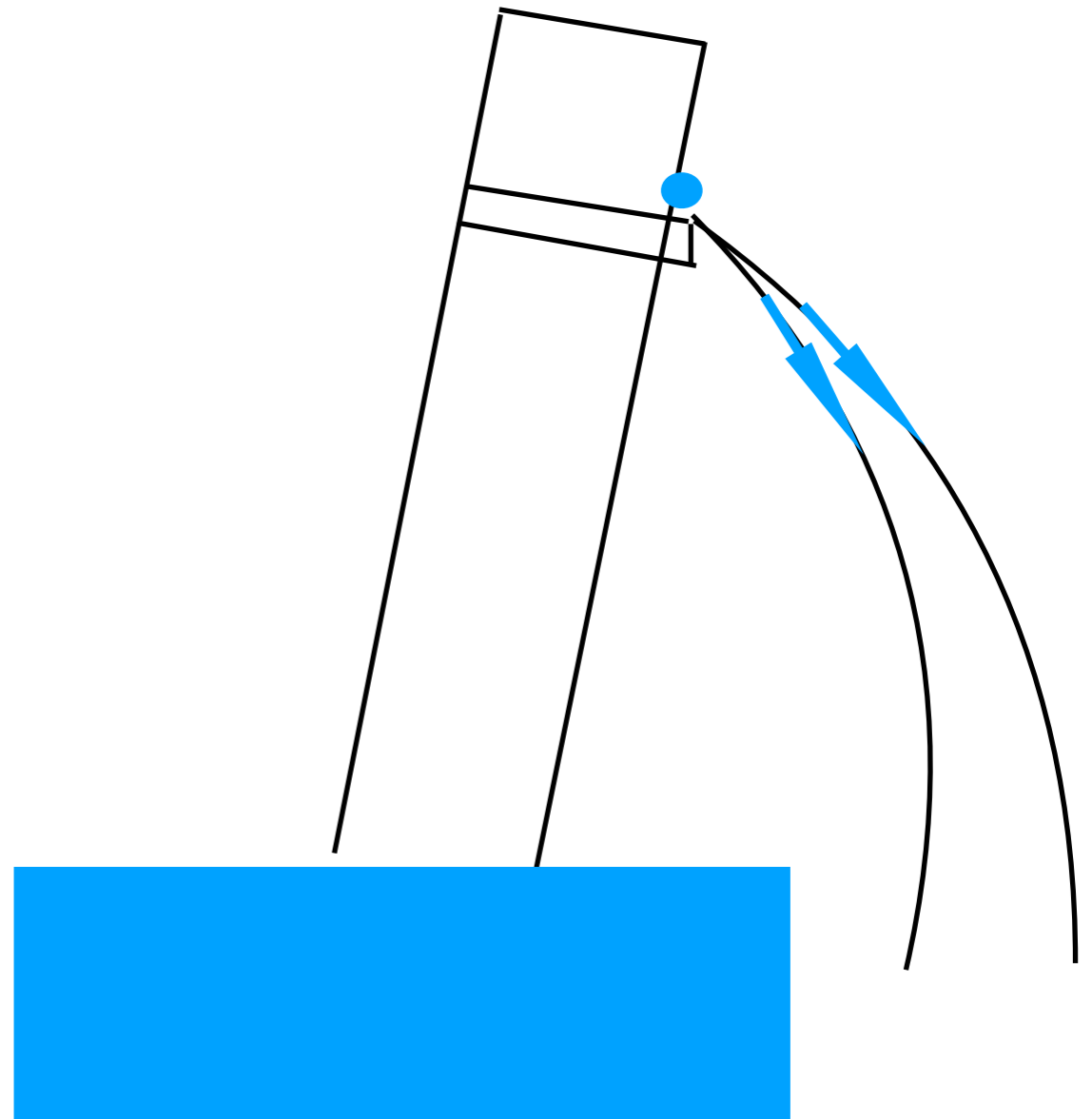
Gender, Feminism & Physics

ASET Colloquium TIFR, Mumbai
Arundhati Dasgupta
University of Lethbridge
December 30th 2019

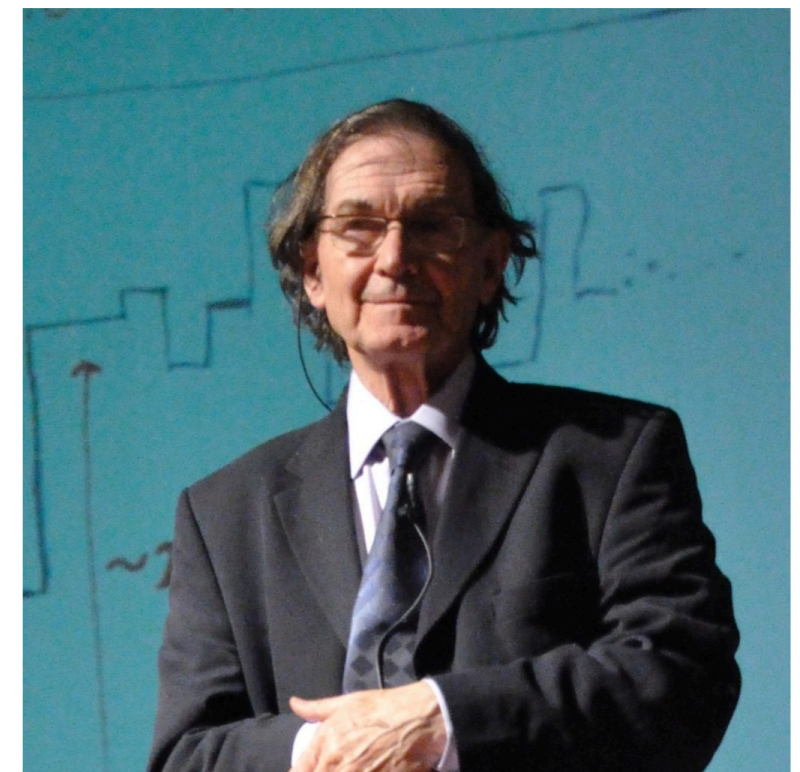
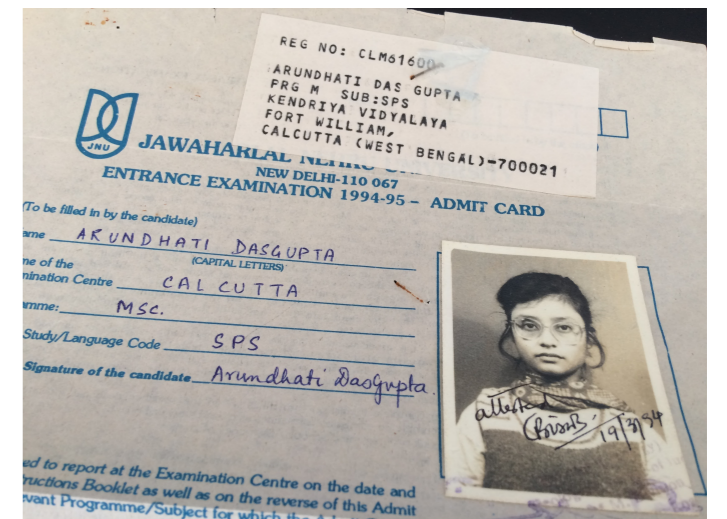
Why?



Painting Justus Sustermans (wikipedia)

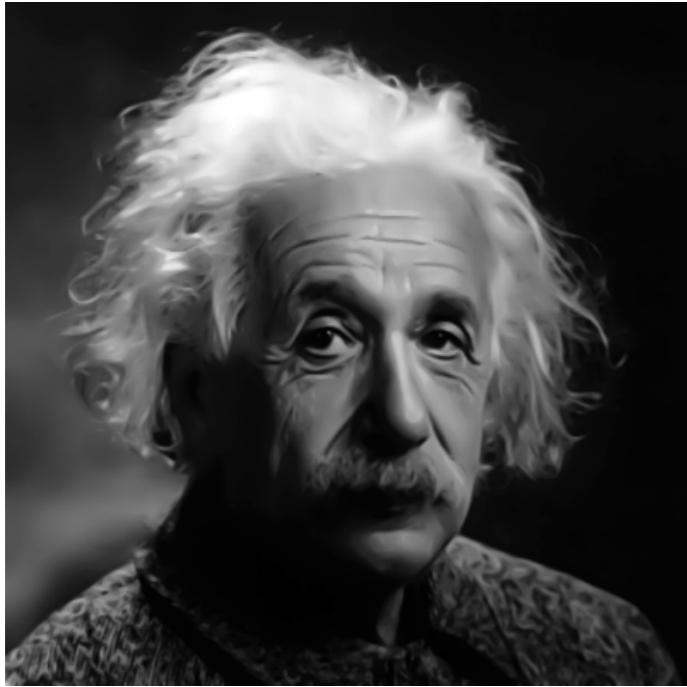


Negotiating a Career in Physics



PC: Sean Carroll's blog

What is your physics identity?



$$E = mc^2$$

The Female Physicist



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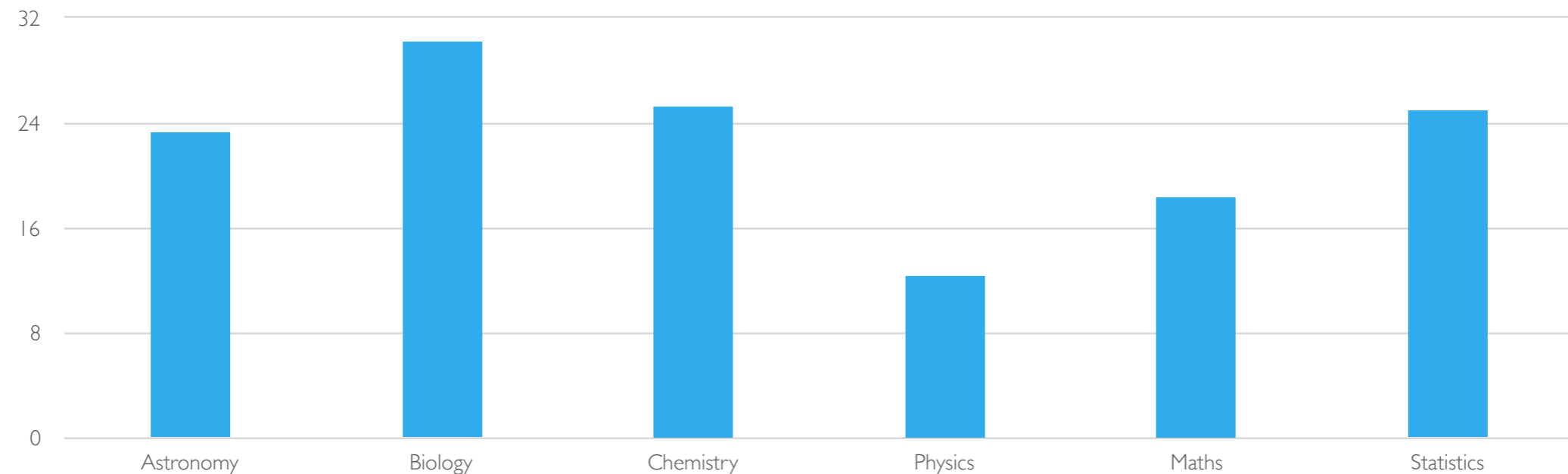
ID

©

The world is not a perfect place

- European Commission Conference on Women in Science (2000)
- Londa Schiebinger- What difference do women bring to Science-in Medicine inclusion of more women has ensured more research in women related health concerns
- Christine Wenneras-The Medical establishment in Sweden suggested recruiting women was less prestigious

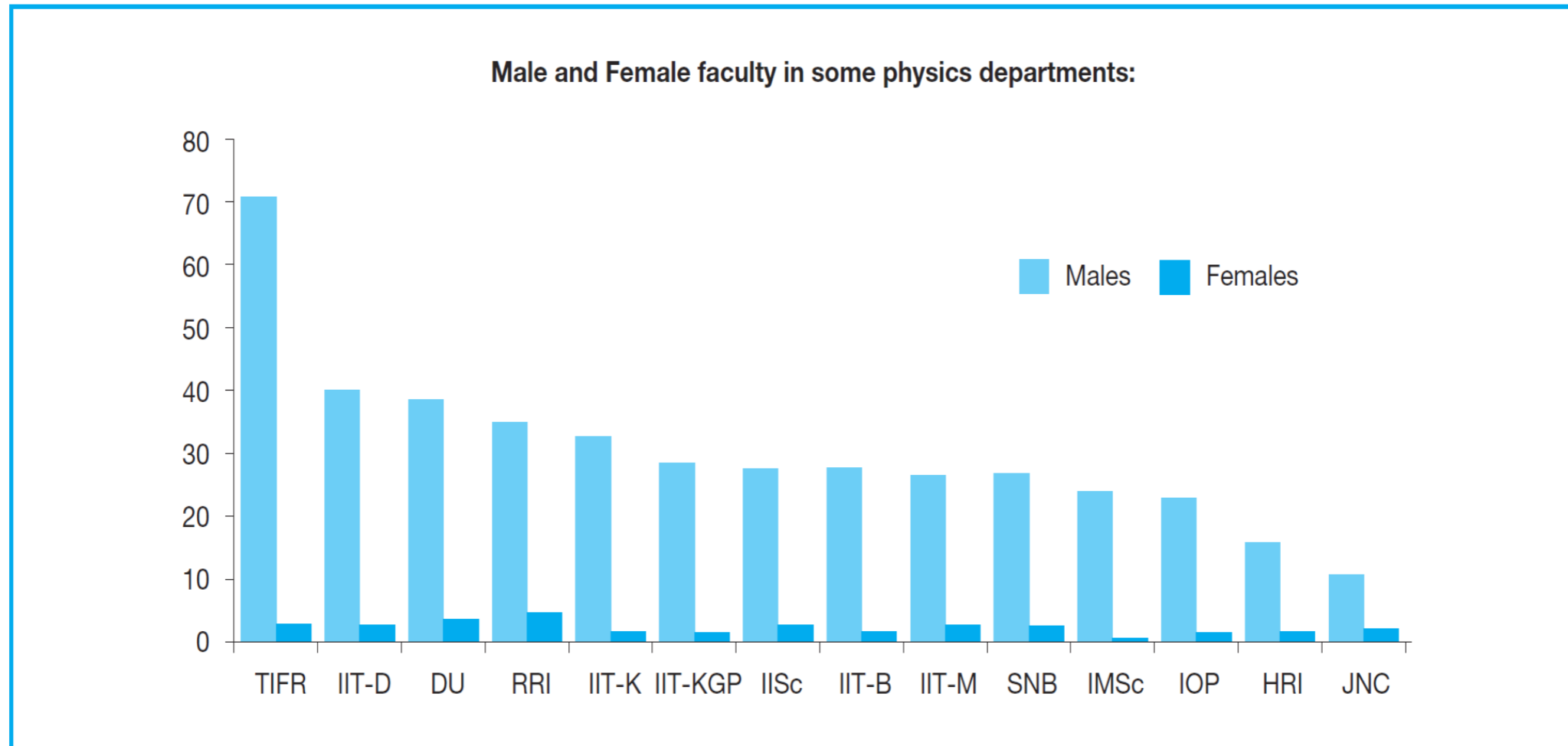
Women in Physics in Canada



Women in Sciences: Canadian Association of University Teachers Almanac (2013-2014)

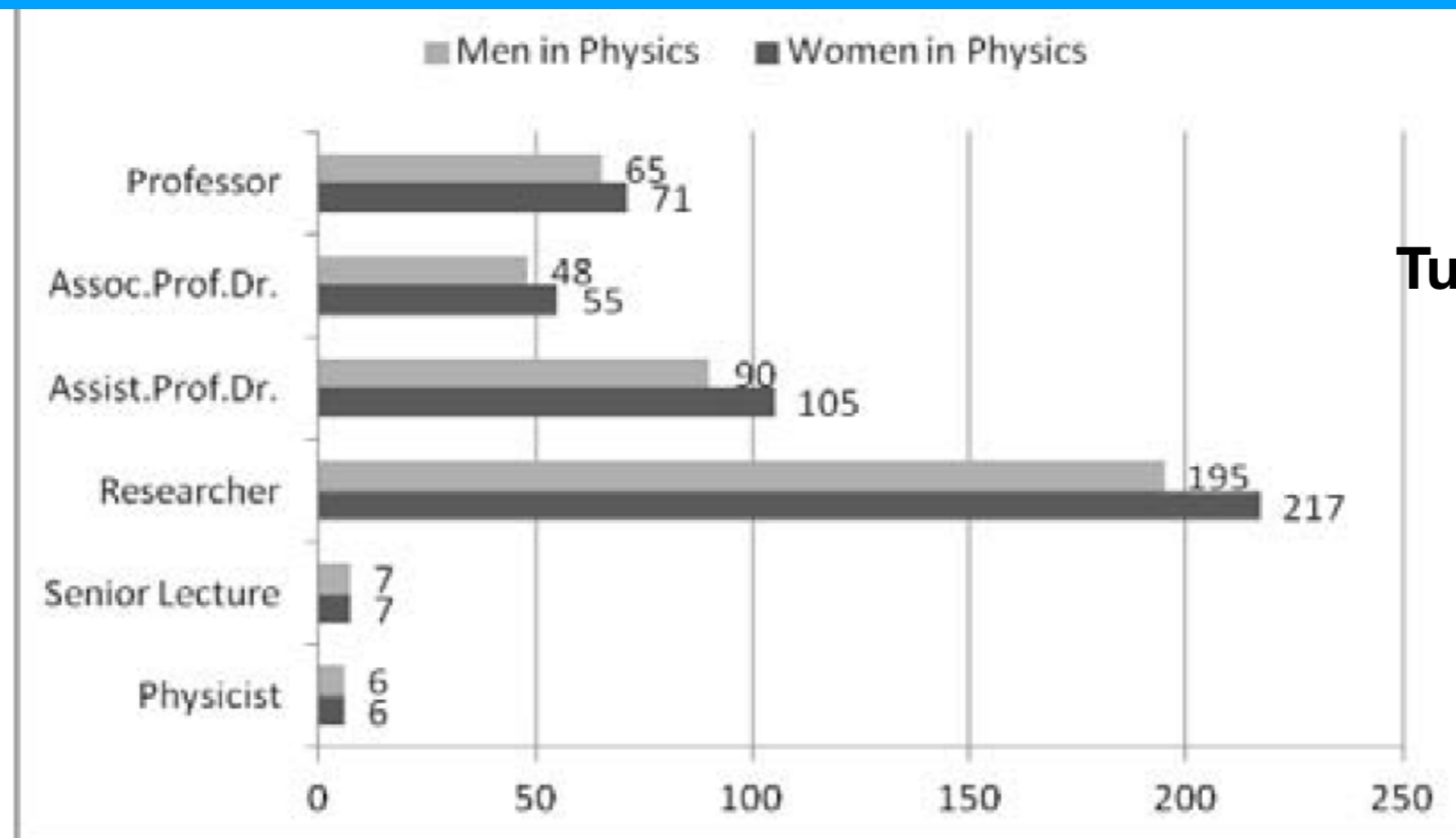
From India

WOMEN IN SCIENCE AND TECHNOLOGY IN ASIA



(2006: Godbole and Ramaswamy)

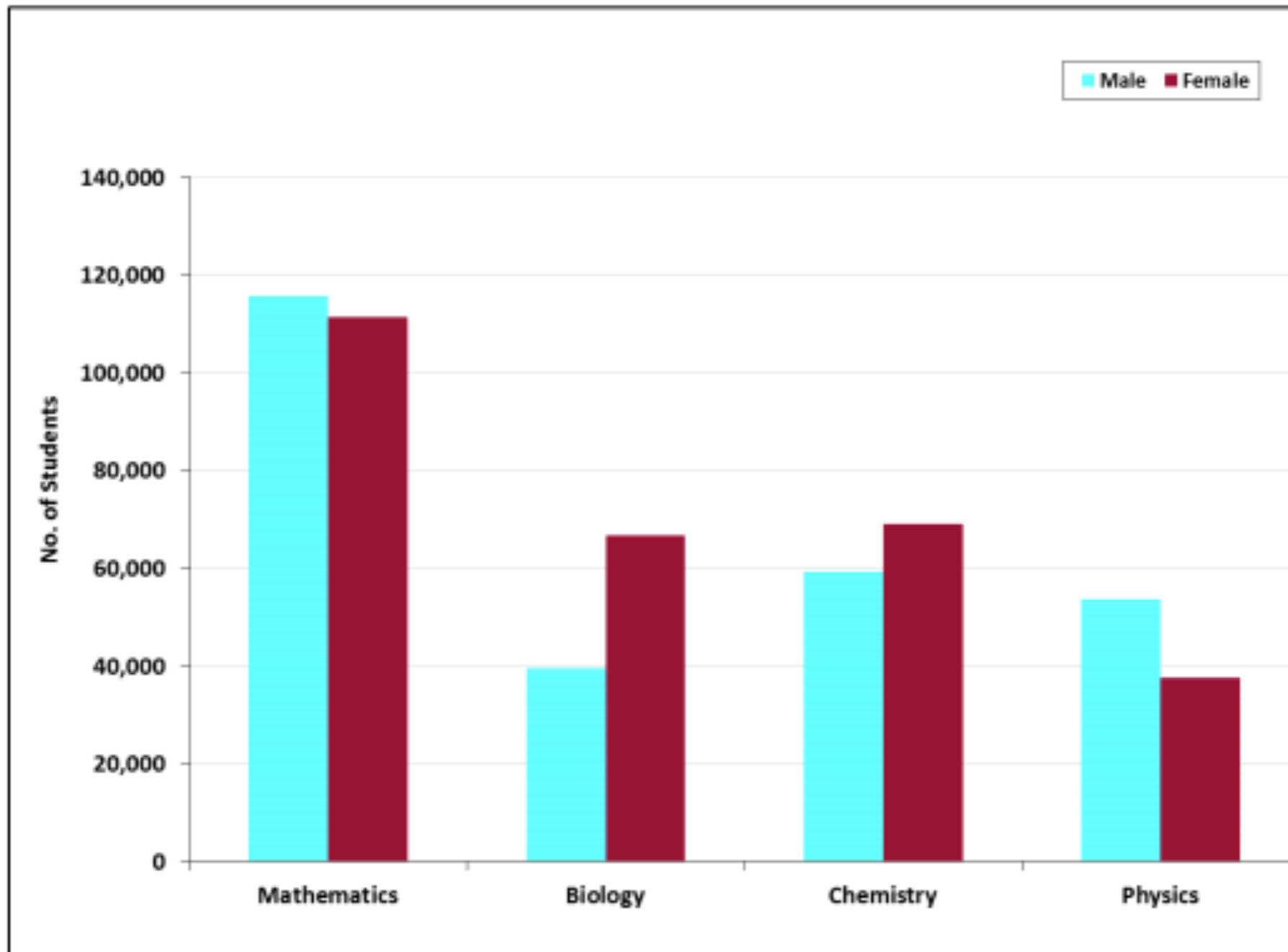
Where are the women physicists?



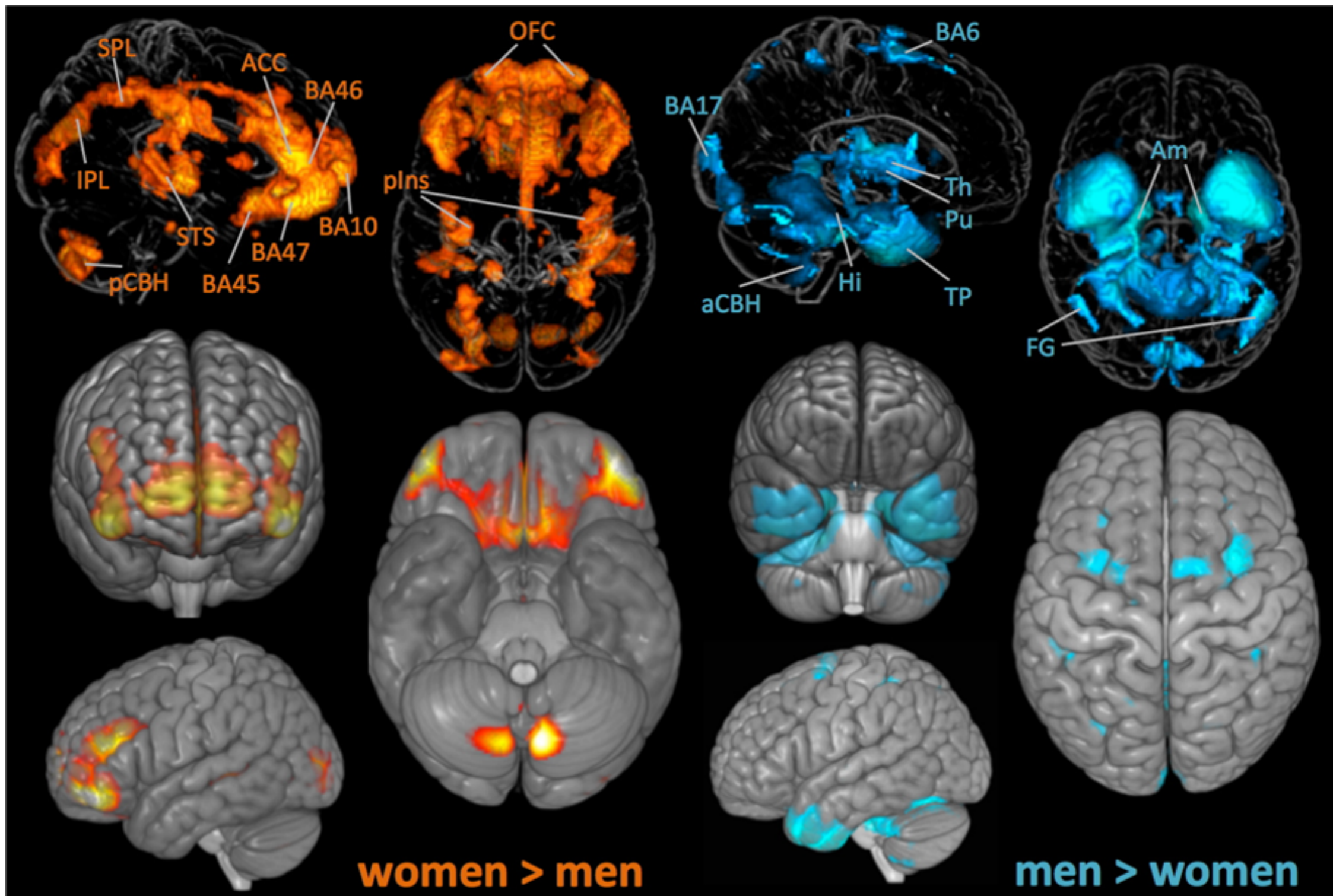
Turkey ICWIP (2014)

Unpopular

- Number of students enrolled or writing provincial exams in Grade 12 , secondary 5 and Cegep 2013 (NSERC Report in 2017)

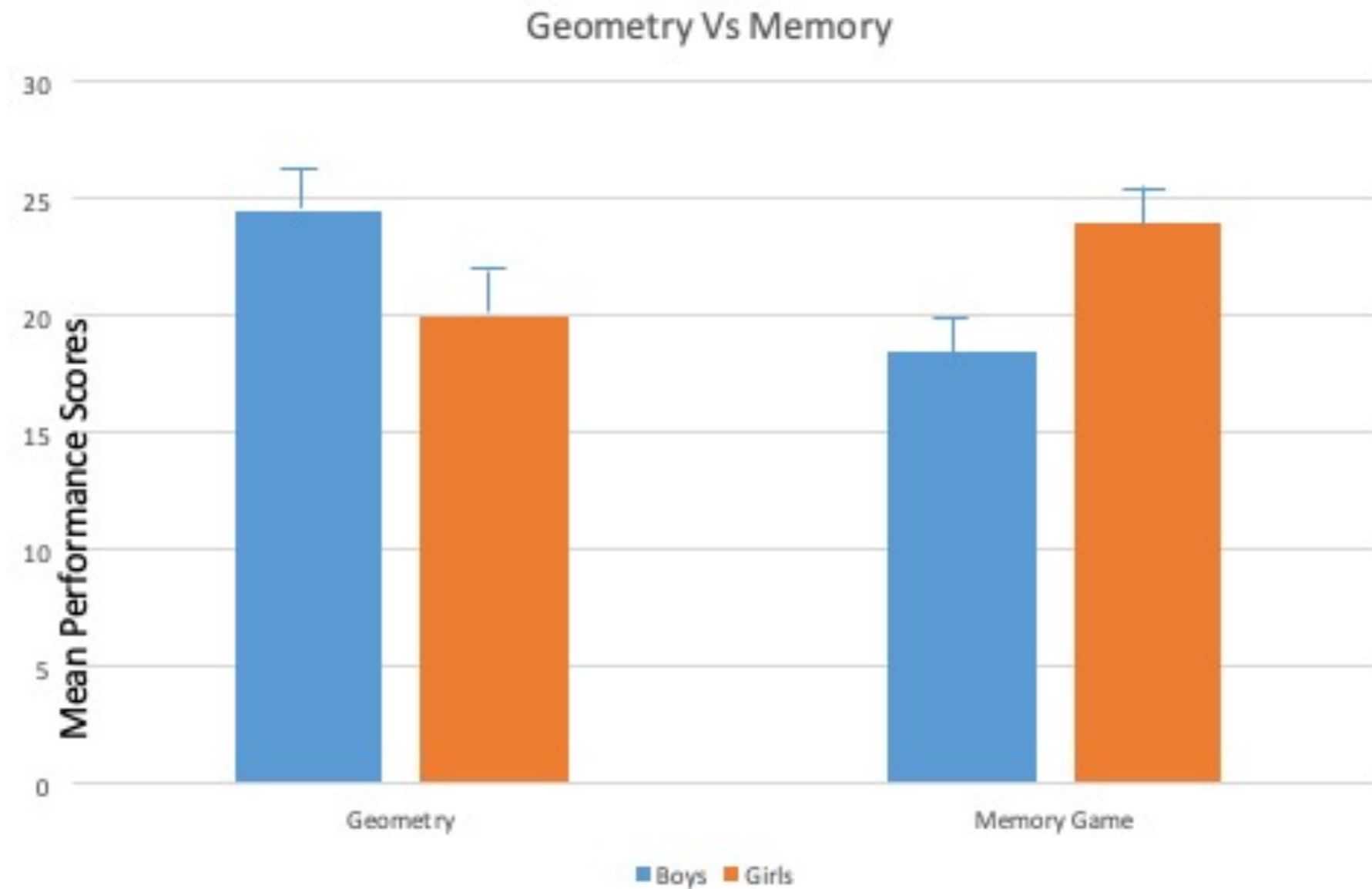


The Human Brain



M. Lotze et al (2019)

Stereotype Threat



S. J. Spencer, C. M. Steele, D. M. Quinn (1999) P. Huguet and I. Regner (2007)

Similar Test in Physics Class rooms (312 physics students in school)

- Nullified Stereotype (students told girls and boys perform equally)
- Implicit Stereotype (no prior information to students)
- Explicit Stereotype (students told boys perform better)
- The performance of boys in implicit and explicit conditions is better than the girls, but the performance of both the genders is same in the nullified stereotype room

G. C. Marchand and G. Tasoobshirazi (2013)

Eric Mazur's Peer Instruction

- Physics is taught in an interactive way and peer discussions are encouraged.
- The girls and boys perform equally in peer instructed courses
- However this gender parity could not be achieved in another University using peer instruction methods, so this experiment could not be confirmed
- Physics problems have yet to be assigned in gender neutral language.
- Equal scores have been achieved in Math tests using 'gender sensitive' math problems

Feminism



Book of the City of Ladies (15th Century)

**Vindication of the rights of women
(18th Century)**



Suffragette Movement (19th Century)

NON-VIOLENCE

Age-Time Period	History	Women
2.6 Million Years -1200 BCE Palaeolithic Age	tool building nomadic living	Women shared equally in tool building and maybe also in hunting
12,000-3,000 BCE Neolithic Age	Early River settlements Writing develops in Egypt	The women farmed; considered equal
3,300 BCE- 1200 BCE Bronze Age	Egyptian, Mesopotamia Indus Valley; European - Chinese Settlements	Indus valley was a matrilineal society In Egypt, queens led armies
1200 BCE- 100 BCE Iron Age	Iron tools, Greek and Roman Empires Plough-Agriculture	Patriarchal societies emerging, Europe-Egypt woman
1-1099	Rise of Christianity, Islam Buddhism	Patriarchal
1100-1299	Age of the Crusades, Marco Polo	Patriarchal; Women managed estates and served in Crusades
1300-1599	Empires, wars Renaissance Explorations and Discovery Beginnings of Slavery in America Reformist movements in Europe	Patriarchal but heroic stories of Joan of Arc writers, rulers, artists nuns, Witch hunt
1600-1799	Galileo, Protestants, French Revolution Colonialism	Patriarchal, though astronomers Midwives, scientists have been recorded
1800-1899	Colonialism Industrial Revolution American Civil War, End of Slavery	Victorian segregated life, but women writers, scientists, Marie Curie
1900-1949	The world wars, Inventions Communism, Capitalist Recession	Vote, Nobel prize for women liberated life
1950-2000	De-colonialism, Cold-War era Space-Age, Landing on Moon Fall of the Eastern bloc, End of Apartheid	Post war women out to work & Disarmament equality at workplace
2000-2020	Refugee flow, LGBTQ movement Climate Change	Environmental Activism Women in Sciences



AGRICULTURE AND PATRIARCHY

This gradual decline of the status of women in the river valley civilizations has been attributed to agriculture. A clear correlation has been found between the regions which adopted plough agriculture and the status of women in that society. The correlation between the decline of female participation in labour force and the use of plough in agriculture is very strong (0.86) .

A. Alesina, P. Giuliano, N. Nunn (2011)

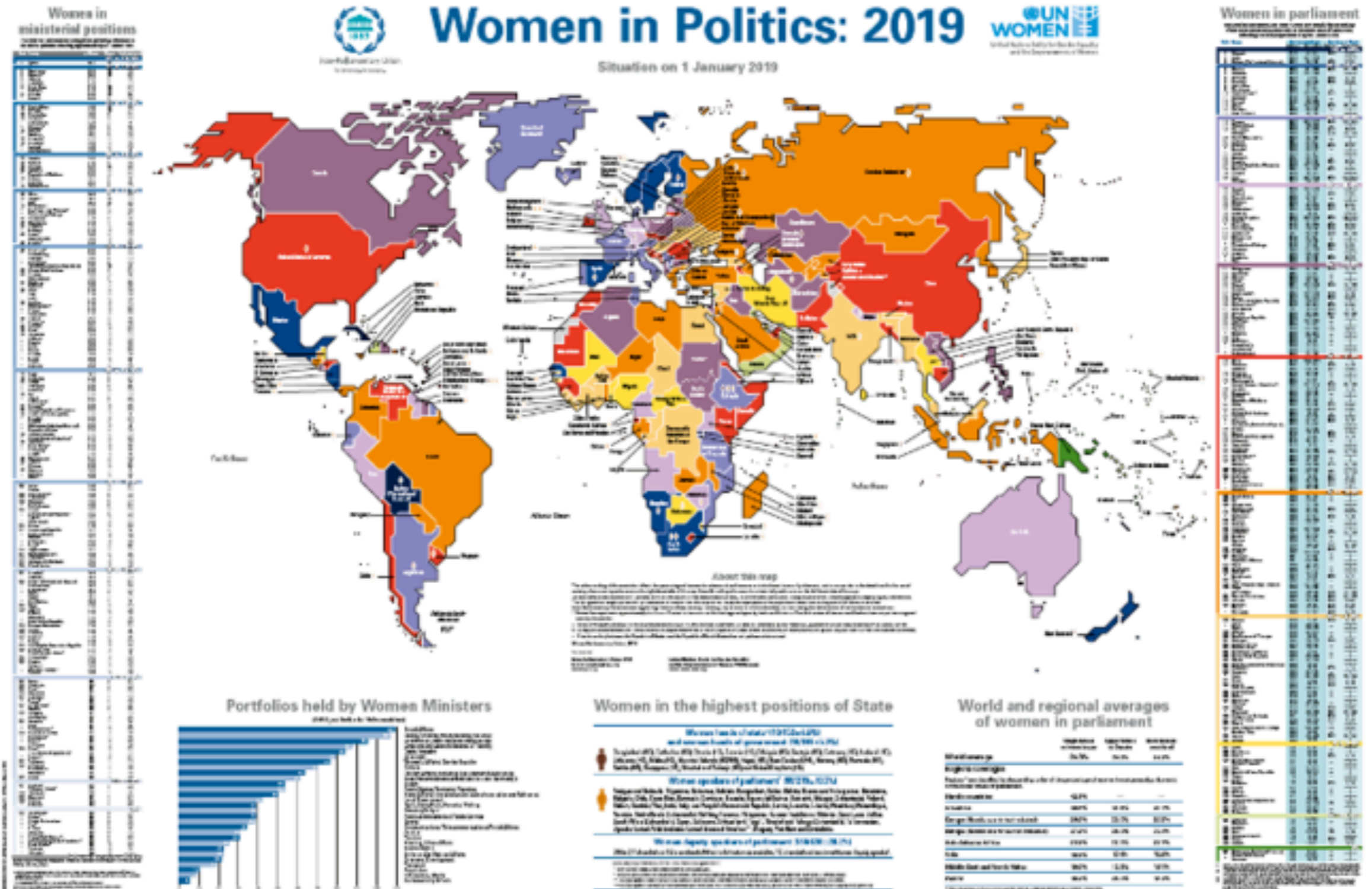
In ethnographic data from shifting agriculture based communities, the discrimination against women is lower.

Women and War

Women in ancient Egypt participated in war, and Egyptian queens led armies from the front. In later periods every region of the world has stories of women who have taken up arms and fought 'enemies' on battle field.

Women are capable of fighting, and in the current status of liberal feminism, modern armies have women contingents in the infantry, navy and airforce. But it is a profession women are indeed very under-represented. Women comprise about 14% of the US army active deployed forces. Canadian women also comprise around 14.8% of the armed forces.

Women in Power and Leadership



Women and Cognition

d-Index

$$d = \frac{M - F}{\sigma}$$

In Math

$$d = 0.0065$$

In Reading

$$d = -.11$$

In Mathematics Computation

$$d = -0.14,$$

In Mathematical Concepts

$$d = -0.03$$

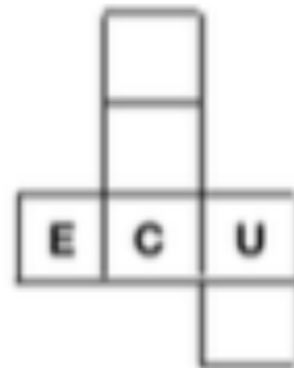
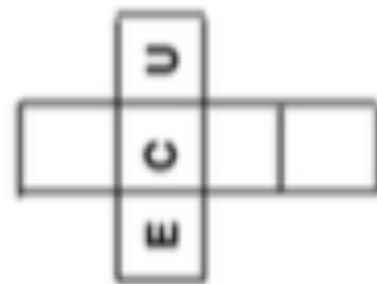
In Problem Solving

$$d=0.08.$$

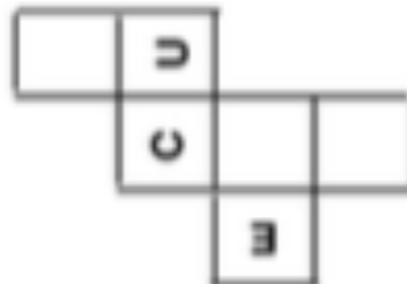
J. S. Hyde (2005)

Spatial Skills

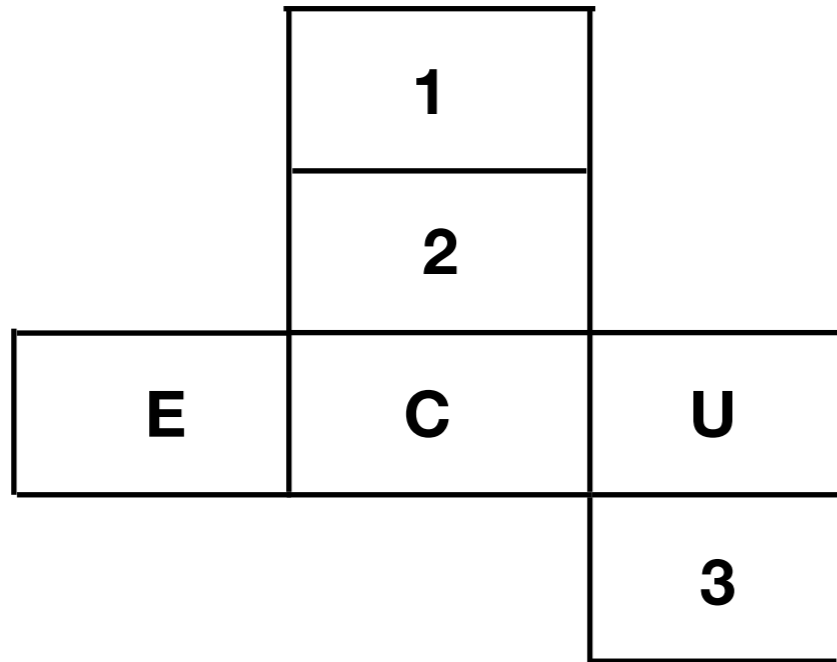
$$d=0.56$$



Place 'B' in the box to complete the CUBE when folded



Where is the B in the Cube?



This skill can be acquired through training; A course in spatial skills increased the retention of female students in engineering courses by 30%

Why are women not studying physics?

- There are very few women in Physics
- Not yet anyone of the status of Newton and Einstein
- **Virginia Woolf asks this question in her famous essay 'Room of ones Own' and 'Three Guineas' (early 20th Century)**
- **'You will not produce a big Newton until you have produced a considerable number of lesser Newtons'**
- **"it is not education that is needed. It is that women should have liberty of experience, that they should differ from men without fear and express their difference openly"**

Masculine/Feminine

- 1. Objective / Subjective**
- 2. Quantitative / Qualitative**
- 3. Rational / Emotional**
- 4. Detached / Personal**
- 5. Logical / Intuitive**
- 6. Abstract / Concrete**
- 7. Theoretical / Practical**
- 8. In the lab / In the every day**
- 9. Elite / Accessible**
- 10. Authoritative / Egalitarian**
- 11. Value-free / Value-laden**
- 12. Universal / Local**

Multiple Subjectivities

Gender and Physics

- Physics is the study of matter and its interactions; what does gender which is a social construct have to do with physics ?
- What is Gender:
 - ***the state of being male or female (typically used with reference to social and cultural differences rather than biological ones).— Wikipedia***
 - ***Body***
 - ***Identity***
 - ***Expression***
 - **Gender Roles: Feminine->gentleness, empathy, sensitiveness**
 - **Gender Roles: Masculine->Aggressiveness, Independence, Courage**
 - **Where in the Gender Spectrum should the culture and practice of physics be?**

Modern Physics

- **Newtonian Mechanics**
- **Maxwell's Equations**
- **General Relativity**
- **Quantum Physics**
- **Nuclear Physics**

- **Deconstructing the Universe**

-

- **CMB**
- **WMAP**
- **X-ray telescope**
- **Event Horizon Telescope**
- **BioPhysics**
- **Neurophysics**
- **Econophysics**
- **Medical Physics**

S. Kauffman

**“A world beyond Physics:
The emergence and evolution of
life” (2019)**

- **COMPLEXITY AND NONLINEARITY**

Applied Physics

- Light Bulb 😊
- Steam Engine 😞
- Nuclear Energy 😞
- Atomic/Nuclear Bombs 😞
- Fusion Energy 😐
- Batteries 😊

Nuclear Energy

- **1895-1945 -Radioactivity, Fission**
- **1939-1945 –Accelerated research with focus on developing the atom bomb**
- **1945- Use of Nuclear Physics for Peaceful purposes like electricity**
- **1956-Building `reliable power plants`**

Nuclear Activism

- In 1961 50,000 women marched for 'Women Strike for Peace' in 60 cities all over the world
- In 1963 the 'Partial Test Ban Treaty' prohibiting atmospheric nuclear ban treaty
- In 1975 a proposed Nuclear Power plant in Wyhl, Germany was cancelled due to anti-nuclear protests
- In 1982 one million people protested Nuclear Weapons and Cold War Arms race in New York
- In 2008 the international conference of nuclear disarmament happened under the leadership of Norway
- Germany led by Angela Merkel has decided on a complete phase out of the Nuclear power plants in this decade.
- Nobel Peace prize in 2017 went to International Campaign to Abolish Nuclear Weapons (ICAN)



Gender and Leadership

- There are great leaders and there are great women leaders
- Political Thinkers, Scientific Pioneers, Inventors



La Tour

MARIE CURIE

She had an obsessive quality which kept her dedicated to her research. This helped her discover the new elements of polonium and radium. She had scientific vision, and had started the project on radioactivity herself, before Pierre Curie joined her.


She also showed great resilience in building a career in physics, as her homeland Poland did not allow women in education. She faced great discrimination even in France her adopted homeland. If it had not been for Pierre Curie, who refused to accept the Noble prize without her, the Nobel committee would have overlooked her. She went to win a second Nobel prize in Chemistry in 1912. Her leadership skills emerged when she served in the war as the director of Red Cross Radiology Services, and also when she set up the Radium Institute in 1912. She ensured that the expertise she had in radioactivity found useful applications in industry and in medicine.

URSULA FRANKLIN

Science extends into the social milieu around us, and our professions extend into the outer community. This is very important, and Ursula Franklin was an exemplary scientist, not only for her publications, but also for her pacifism and feminism. Her work on Strontium-90 in children's teeth was used for nuclear activism, and the nuclear atmospheric testing was banned. Her ideas on feminism, and pacifism were far ahead of her time. She worked for the Canadian Science council, and helped shape Canadian science policy. She was a contributor to the document 'Canada as a conserver society'.

She envisaged women as different from men, capable of looking at the world in a different perspective. According to her: "Feminism isn't an employment agency for women; it's an alternative way of ordering the social space, in which women are the prototype rather than men. It is based on collaboration rather than competition. As a youngster, I still remember my feeling of joy that one could look at the earth differently. That's feminism; everything is differently oriented. Seeing the same world with different eyes."

Name these female scientists

She inspired the Carl Sagan novel 'Contact' and the Hollywood film based on that, featuring Jodie Foster. A pioneer in astronomy, her thesis studied small mass objects which she named as 'Brown Dwarfs'. After graduating she spent most of her active life searching for alien life. She retired as the director of Centre for Search for Extraterrestrial Intelligence (SETI). She is one of the modern women, leading work in scientific sphere. We wait for the signal from an Alien, to make  a legend.

Jill
Tartar

She led two major particle physics projects, one of which ATLAS led to the discovery of the Higgs Boson. She is the director of CERN, the world's largest collider. She has been awarded 'The Enrico Fermi Prize' of the Italian Physics Society, and the Fundamental Physics Prize of 2012. Her approach to leadership has been described as collaborative and inclusive.

Fabiola
Gianotti

International Conference of Women in Physics

The International Conference of Women in Physics (ICWIP) working group was formed within the International Union of Pure and Applied Physics (IUPAP). This conference aimed at providing network for women scientists has successfully gathered more than 200 scientists from more than 50 countries, every three years ever since its inception. Women physicists from all over the world come together to provide details about the situation of women in their country and brainstorm about methods to improve the situation. The working group adopts resolution for recommending to the IUPAP general assembly, where these are passed as resolutions to be implemented. Every three years, the conference is held where women report on the improvement since the last conference. As an example we describe the most recent conference held at University of Birmingham in 2017. The conference with the aim of doing away with divisiveness, instead of competition, and encouragement instead of elimination. The order of talks were random, the name tags, well, just had our and our university names, and we were requested to sit next to a physicist from a different country at each session. The paper proceedings were assigned referees who discussed their concerns with the authors, and there was no anonymous refereeing.

Gendered Power

Masculine leadership is adjudged as dictatorial, goal oriented, whereas female leadership is considerate, transformational and people oriented.

Effectiveness of feminine leadership is more in team based collaborative projects. Given the large projects of today's science, feminine leadership might be useful.

The gravitational waves project, the recent event horizon telescope project, the particle physics experiments all comprise of 1000 of physicists working towards a discovery, and this will be a norm in the future.

Is reality Gendered?

**Science is a subjective experience and very masculine in it's attempt to
`master nature`
-Evelyn Fox Keller**

**The Linearity of Newton's Laws is oppressive and Masculine; whereas
the `uncertainty' of Quantum Mechanics is feminine
-Karen Barad**

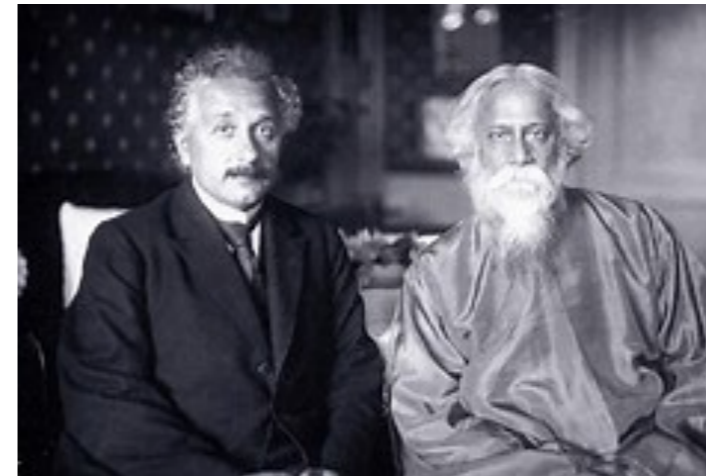
**A Physics with feminine consciousness would be constructive and not
de-constructive; complexity and non-linearity would be appreciated.**

Tagore and Einstein

Discussions on Objective and Subjective Realism?
Is there Free Will?

Quantum Physics is emerging in the way Tagore had predicted-I. Prigogine

With my senses' hues
Emerald as green I muse
And the coral as red;
As my sight I spread
The sky is luminous
East to West with light glorious;
To rose I said, "Bonny is thee"
And so did she be!
Esoteric it is, you'd say;
Words of a poet, nay.
I'd say, "'tis truth and poetry so;
For the mankind, my ego;
On which canvas
The Creator's artistry does pass.
The hermit breaths "no, no, no;
Mere myths are these that go;
No emerald, no coral, no light, no rose,
Neither 'you' nor 'me' should you suppose



On the other hand, He the Infinite

Science of Consciousness

- ORCHOR Theory of Penrose
- Consciousness is an orchestrated quantum computational process in neuronal microtubules a phenomena which then `collapses from the quantum wave function' to a classical state ('Objective reduction')
- IIT Theory of Giulio Tononi
- Integrated Information Theory



Intrinsic Experience

Integrated Information Theory



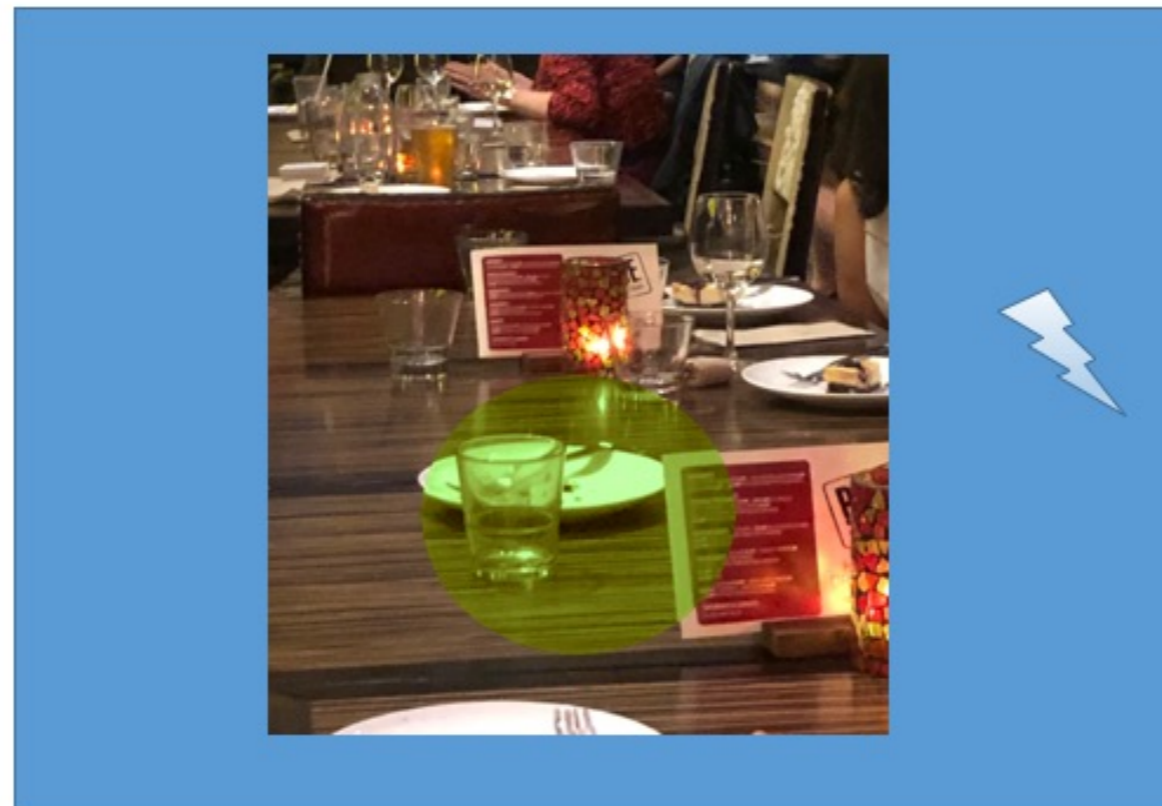
- Composition.

Integration



Information

Exclusion



Perceptronium

$$I(X, Y) = S(X) + S(Y) - S(X, Y)$$

x/y	p(x)	p(y)
0	0.75	0.5
1	0.25	0.5

X/Y	y=0	y=1
x=0	p(0,0)=0.25	p(0,1)=.0.25
x=1	p(1,0)=0.0	p(1,1)=0.5

$$I(X, Y) = S(X) + S(Y) - S(X, Y) = 0.095$$

G-Perceptronium

X/Y	y=0	y=1
x=0	p(0,0)= 0.30	p(0,1)=0.21
x=1	p(1,0)=0.04	p(1,1)=0.45

$$\Phi = 0.0338$$

The G-Perceptronium is different from the previously calculated one

Feminist Materialism

Feminist materialism is another aspect which is being currently discussed as aspects of subjective realism, and which affect choices women make in their careers. Karen Barad, a theoretical physicist, and a philosopher, has through her writings brought forth a collaboration of the material world, the biological body. Her interpretation of the quantum theory as entangled with various thought processes of today including feminism, provides seeds for a new 'feminist materialism'.



Gender, Feminism, Physics

EFFICACY

- It is almost 50 years since Vera Rubin showed that the galaxies rotate in a way where there might be additional matter away from the centre, decades since the cosmologists found that the universe is accelerating and we haven't found dark energy or dark matter.
- If the field was more open and less insular a young girl from Tunisia might have had the ideas of how to solve the dark energy and the dark matter puzzle.