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Women in Astronomy and in Science: cracking the code with a third culture

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Abstract. Girls' under-representation in science, technology, engineering and mathematics (STEM) education is deep rooted and puts a detrimental brake on progress towards sustainable development. Both education and gender equality are an integral part of the 2030 Agenda for Sustainable Development, adopted by the United Nations General Assembly in 2015, as distinct Sustainable Development Goals (SDGs). The UNESCO Report: *Cracking the code: Girls' and women's education in STEM* provides a global snapshot of this underrepresentation and the factors behind it. The fight against stereotypes to 'crack the code', or to decipher the factors that hinder or facilitate girls' and women's participation in STEM (and particularly in Astronomy) education must take into account the persisting dichotomy between the so called two cultures.

Keywords. history and philosophy of astronomy, sociology of astronomy, miscellaneous

1. Introduction

C. P. Snow lamented in his book *The Two Cultures and the Scientific Revolution* the gap between scientists and literary intellectuals (Snow 1969).

The two cultures, the scientific and the humanistic, do not talk each other. Between the two languages there exists a wall that only a limited number of people with a deep knowledge of both are able to overcome. One could say that a bridge needs to be built between the two cultures, namely a common background which favours reciprocal understanding. The gap between Humanities and Sciences has been deeply investigated by the intellectuals of the so-called *third culture*, who want to promote a new alliance between the scientific and humanistic culture (Brokman 1995). Iinside such a third culture the two communities of intellectuals could have a fruitful dialog. Each community would take advantage of the point of view of the other. For example philosophers could benefit from the rigour and nature-centred point of view of scientists, and scientists could take advantage of the critical attitude of philosophers.

A third culture would also unify arts and sciences, because the artists' and scientists' creative processes are very similar. The scientist, the poet, the painter, the philosopher create their works using similar inner processes which mainly consist in making a bricolage of elements already known. These elements are combined to give a totally new representation of nature, of man or of life. Therefore both artists and scientists are involved in intuiting change of perception of the world and materialising it for others to experience, see and eventually change. In such a creation, the scientist, the poet, the painter, the philosopher are deeply emotionally involved. A third culture would integrate sensitivity and Sciences, by introducing the awareness of the emotions involved in the scientific discovery (Curir 2014). According to Théodule Ribot *an idea is nothing more*

than an idea, a simple fact of knowledge, it does not produces nothing, it can't do anything; it only acts if it is felt, if there is a emotional state to accompany it, if it awakens trends, motor elements (Ribot 1896).

A third culture would be more multidisciplinary and less sectorial, a scientist of the third culture would be similar to a 'natural scientist' of the 18th century (Curir 2018).

An uneven gender distribution amongst the two cultures can be observed: amongst academics in the fields of hard Science, men are clearly predominating. In some fields of the Humanities, there is a predominance of women. The support to a third culture would be a support to equity for women in Science.

2. UNESCO: cracking the code – girls' and women's education in STEM

The UNESCO report *Cracking the Code – girls' and women's education in STEM* tell us that gender differences in STEM education at the expense of girls are already visible in early childhood care and become more visible at higher levels of education. Girls appear to lose interest in STEM subjects with age, and lower levels of participation are already seen in advanced studies at secondary level. By higher education, women represent only 35% of all students enrolled in STEM-related fields of study.

Neuroscience reports differences in brain structure and functions between men and women (Ruigrok et al. 2014) but few differences have been found between boys' and girls' brains relevant to learning (Eliot 2013). Studies on the neural basis of learning have not found that boys and girls master calculation or other skills differently and no difference in brain composition can explain gender differences in mathematics achievement (Spearman & Watt 2013).

Girls are often brought up to believe that STEM are 'masculine' topics and that female ability in this field is innately inferior to that of males, whereas they do not feel so inferior in humanities studies. This can undermine girls' confidence and willingness to engage in these subjects. Supportive learning environments can increase girls' self-confidence and self-efficacy in STEM. The fight against stereotypes to 'crack the code', or to decipher the factors that hinder or facilitate girls'y and women's participation in STEM (and particularly in Astronomy) must also take into account the persisting dichotomy between the two cultures and the uneven distribution of women between them. Teaching Astronomy as a third culture discipline will surely have a central role in determining girls' interest in this subject and in providing equal opportunities to access.

3. Astronomy as a third culture

Most ancient cultures saw pictures in the stars of the night sky. The earliest known efforts to catalogue the stars, with cuneiform texts and artifacts, date back roughly 6000 years. These remnants found in the valley of the Euphrates River, tell us that our ancestors observing the heavens saw the lion, the bull, and the scorpion in the stars. By the 5th century B C most of the constellations had come to be associated with myths, and the Catasterismi of Eratosthenes completed the mythologization of the stars. At this stage, the fusion between Astronomy and mythology was so complete that no distinction could be made between them. Therefore in ancient Astronomy the narration, the myths, and the observations and measures were interlaced: Astronomy is the first third culture.

Modern Astronomy and Cosmology are important examples of sciences which were progressively abandoned as sciences based on human centrality in favor of a perspective where man is projected in a stream of time. Indeed, Astronomy and Cosmology put us in a continuous contact with a reality which is deeply 'historical and evolutionary'. An atomical physicist can ignore the history of the reality of which he is studying the model, but a cosmologist must always take into account the history and the evolution

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of the phenomena he is dealing with. Therefore the astronomer and the cosmologist are forced to think in terms of a Natural History which links together Cosmology, Biology and Historical Sciences. Also because of such a structural opening, modern Astronomy and Cosmology have the connotation of a third culture.

4. Metaphors in Science

Evelyn Fox Keller stressed the ubiquity of metaphors in scientific discourse, necessary for generating knowledge about a world not yet known. The scientist seeks understanding of the not yet intelligible by comparison with that which is already familiar. Nevertheless, what we confront is something new, not contained in the world we already know, and so the analogical relation is not quite sufficient. Indeed, the essence of a metaphor is precisely the juxtaposition of similarity and difference. And the instability it generates by virtue of its insistence on both similarity and difference is essential to the logic of scientific discovery (Fox Keller 2020). Fox Keller put emphasis on Bohr's acceptation of both the competing metaphors about light: light as particles and light as waves. The new quantistic paradigm was created by overcoming this duality and accepting both the metaphors. Through their dynamic interaction, Keller points out, metaphors define the realm of the possible in science (Fox Keller 1995).

But the objects of Astronomy are many metaphors at a time: a black hole is an exact solution of the Einstein's equations, but also an active galactic nucleus, an X-ray emitter, a radio source... Moreover, the astronomical research involves many disciplines: Thermodynamics, Fluid Dynamics, Nuclear Physics, Chemistry, Special and General Relativity, to tell only some of them, but also, as we mentioned, Historical Sciences, Biology, Archeology. Astronomy is intrinsically a third culture: because its primordial roots are interlaced inside narration and measure, mith ad observation. And because its modern version is integrating different disciplines and metaphors of interpretation and these interpretations are embedded in time stream dimension.

5. Some hypothesis about women's intelligence

Our *gendered world*, Gina Rippon says, shapes everything, and generates *gendered brains*. With the discovery of the brain plasticity, we know now that the brain is much more a function of experiences. If you learn a skill your brain will change, and it will carry on changing. Once we acknowledge that our brains are mouldable, then the power of gender stereotypes becomes evident. If we could follow the brain evolution of a girl or a boy, we could see that right from the moment of birth these brains may be set on different roads (Rippon 2020).

Although neurobiological explanations about male and female thinking and learning styles are controversial, it has been argued in some Cognitive Psychology studies that whereas men tend to look for abstract and theoretical arguments, dissociating them from any distracting information, women are more apt to see and make connections between ideas and the larger context (Halpern & Lamay 2000; Kimura 1999; Kimura 2004).

It is often argued that women are more oriented toward and better at assimilating diverse forms of information whereas men prefer to isolate explanations and excel in tasks requiring more local processing (Wyer *et al.* (2001)).

If women intelligence is more naturally multidisciplinary, the perception of Astronomy as a multidisclipinary third culture should encourage women to challenge themselves in such a discipline. Moreover, overcoming the gap between Humanities and Sciences to approach a third culture will provide a fertile ground for women's sensibility and for a holistic approach to nature.

This approach cannot be costless. We know that for a successful scientific career the best performance is actually the one focused on a specific field. Becoming very specialized is now more profitable than being involved in different fields and in the connections between them. We must hope for the future a deeper awareness of the importance of a third culture and of a multidisciplinary approach to Science: the development of a richer view of the world.

Rothen and Pfirman in their exploratory paper wanted to focus on intersection between women and interdisciplinary Science. They conclude that gender gaps are complex issues and a justifiable concern for reasons of social equity in Science. Thus, making better use of the talent of female scientists has been a prominent policy objective for at least a quarter of a century. As the data may suggest, it does seem that interdisciplinarity could serve as a strong entry point into scientific studies for women (Rhoten & Pfirman 2007).

There are several examples of women that were interested in Science and Humanities: I mention here Sofia Kovaleskaja, outstanding mathematical scholar and literary writer, Patricia Churchland, who worked on the interface between Neuroscience and Philosophy, and Evelyn Fox Keller who did research in Physics and Biology but also in the History and the Language of Science.

6. Conclusions

It could be that women are well positioned to make major advances in interdisciplinary research; they may like to integrate across fields and approaches. Using interdisciplinarity to attract women, as well as other underrepresented minority groups into Science, could lead to a stable pathway through scientific and academic careers. This point could be more enhanced in the field of Astronomy, due to its intrinsic nature of third culture Science, and interdisciplinary Science.

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