Diversity Across Astronomy Can Further Our Research

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Astronomer Amelia Ortiz-Gil delivered a speech on the impact of inclusion and diversity in astronomy at the IAU100 Flagship event in Brussels, Belgium on April 12, 2019. The following opinion piece is adapted from her speech.

Let me start with a small quiz: What do these people have in common?
Leonardo da Vinci, Isaac Newton, John Goodricke, Thomas Edison, Albert Einstein and Stephen Hawking.

They are famous. They were all scientists—all male and white, by the way. And, most interestingly, they all experienced some kind of disability, either physical or cognitive. Da Vinci probably was dyslexic. Newton suffered from stuttering and epilepsy, and probably from some form of autism, too. Goodricke was deaf. Edison was almost completely deaf and had a learning disability. Albert Einstein also had a learning disability and possibly dyslexia, while Hawking suffered from amyotrophic lateral sclerosis (ALS).

They are examples of individuals with a disability that in some way or another found the means and support to thrive—and excel—in science. But how many others have not been as lucky?

There is an unknown but certainly not negligible number of talented individuals that may think they are not apt for science because they have a disability. Often this idea gets reinforced when they find that the required knowledge and tools are out of their reach because these tools are closed behind some barriers. But in most cases these barriers are just the product of arbitrary decisions that are not inherent to the knowledge itself.

Take, for example, a graph. Below are two versions of the same graph (Figure 1). The graph on the left uses only colour for coding, which is highly not colour-blind friendly. The left one uses both colour and shapes to distinguish different lines. This graph is not only more colour-blind friendly; it is also better for anyone who can see it.

People can feel so discouraged by these types of obstacles that they don't even try. And this barrier is made even worse if they belong to a racial or cultural minority or an underserved social group (Hamrick, 2019).

But how many people with disabilities are there? Estimates of the proportion of the population with one or more disabilities are very hard to make because they vary depending on the definition of the term "disability." According to a 2016 report published in the USA, about 11% of the working-age population reported some type of disability. A 2019 report stated that 19.5% of undergraduate students reported a disability (Hamrick, 2019). Another study, this one in Europe, claims that up to 10% of the population, or 2 to 3 pupils in every classroom, are affected by specific learning disabilities, such as dyslexia, dyscalculia and autism

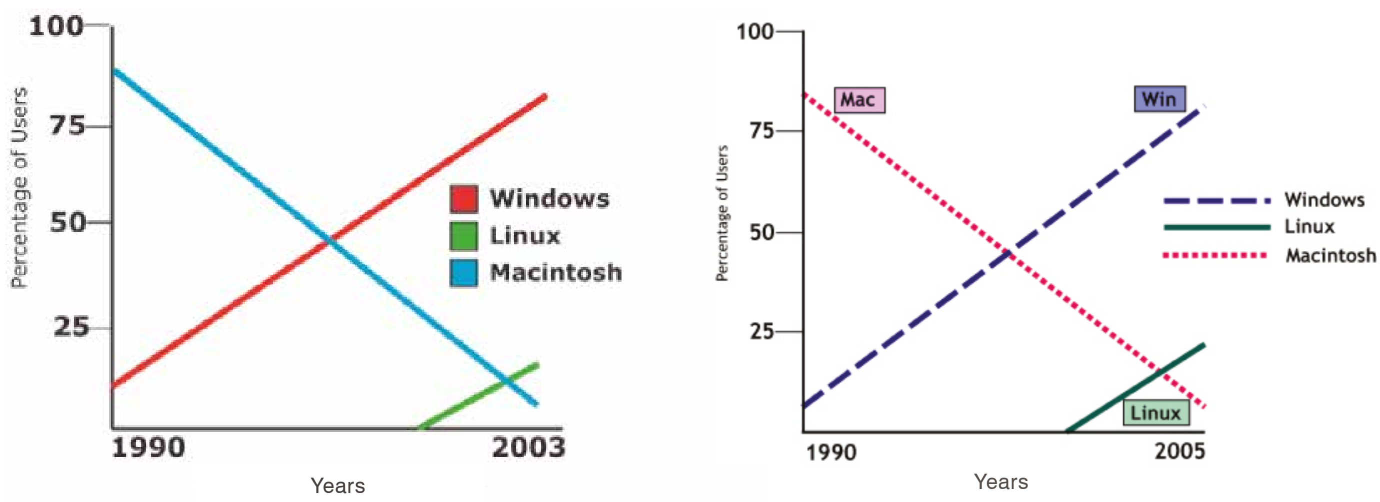

Figure 1. *Examples of graphs that are not colour-blind friendly (left) and colour-blind friendly (right) based on colour and shape. Credit: Penn State University*

(Butterworth, 2013). This study also indicated that children are frequently affected by more than one learning disability.

The report *Women, Minorities and Persons with Disabilities in Science and Engineering* (Hamrick, 2019) from the National Science Foundation provides statistical information about the participation of these three groups in science and engineering education and employment. In summary, it shows how women, persons with disabilities, and minority groups are clearly underrepresented in science and engineering. That is, their representation in these fields is smaller than their representation in the general population. So, what can be done to avoid this loss of talent and to improve the scientific excellence of research groups and institutions at the same time?

The answer is through diversity and inclusion. In the context of this discussion, by diversity I mean a variety of race, gender, functional abilities, socio-economic background, culture, religion, education and so on.

Inclusion is reached by creating a safe environment in which everybody can speak out and act freely without fear of embarrassment, where individuals feel like they belong and have value, and where everybody is treated equally and treated with respect. In creating this safe environment, managers and leaders play a fundamental role, and it is therefore very important that they are committed to achieving inclusion in their teams. It is critical also to embrace the differences, taking advantage of what diversity has to offer, and not to just ignore them and pretend that they do not matter. Finally, diversity and inclusion must go hand in hand because diversity without inclusion is far less effective.

Astronomy is by its own nature an example of inclusion of sciences, as well as culture and philosophy. It gathers together different fields from many other fundamental sciences like mathematics, physics, chemistry, geology and many more. That means that astronomy benefits from discoveries made in other areas, and that astronomy has an influence on those areas, too. This exchange enriches all the sciences involved.

Likewise, diversity in research teams is highly enriching. Diversity in research teams leads to diversity in research methods and diversity in the questions that are being asked. People who are different bring unique information and experiences, broadening the viewpoints and leading to innovative solutions.

During the last decade or so, many sociological studies have found that inclusive and diverse research groups and institutions are more successful than more homogeneous ones. Some of the reasons to support these results are quite intuitive. For example, scientific excellence depends on creativity, and diversity fosters creativity because of people's different backgrounds, abilities (functional or other), culture, and so on. These translate into different ways to address and resolve problems. The search for diversity allows us to draw candidates from the widest possible pool of talent, embracing people that are diverse in background, functional abilities, culture, race, etc. (Harvard, 2018). Not only do they provide new information because of their different backgrounds, but interacting with people who are different forces us to become better, more precise communicators because we have to prepare better, anticipate alternative points of view and expect that reaching a consensus will take effort (Phillips, 2014; Powell, 2018). Diversity also helps us learn to overcome cultural biases and misunderstandings, leading to more tolerant and inclusive environments. Research groups that are diverse report increased productivity, more citations, and increases in grant income (Powell, 2018).

I will just mention a case recently published in *Nature* (Gewin, 2018). The Dunlap Institute for Astronomy and Astrophysics of the University of Toronto in Canada established more equitable hiring practices. And after five years, the percentage of women in the institute rose from 25% to 49%, grant income rose by a factor of 26 and citations increased by a factor of 10. In the *Nature* article, the director of the institute, Prof. Bryan Gaensler, claims that his experience shows that "more-diverse teams lead to excellent research."

Figure 2. Inspiring Stars *logo. Credit: IAU/Inspiring Stars*

On the other hand, in recent years many regulations have been passed at the national and international level concerning accessibility and inclusion policies. I would like to mention one that is relevant in our case. The International Council for Science (now the International Science Council, or ISC), in its Statute 5, presents the Principle of Universality of Science. It includes the need for equitable access to data, information, and other resources for research. And in advocating the free and responsible practice of science, the ISC promotes equitable opportunities for access to science and its benefits, and opposes discrimination based on such factors as ethnic origin, religion, citizenship, language, political or other opinion, sex, gender identity, sexual orientation, disability, or age.

The International Astronomical Union (IAU) is a member of the Council and following this mandate created the Working Group on Astronomy for Equity and Inclusion in 2015, after discussions about it at the 2015 General Assembly in Hawaii. It is currently composed of around 200 members. Most of them are astronomers and experts in accessibility, while some are outreach professionals and educators. The working group deals mainly with the topics of visual impairments, deafness, motor disabilities, neurological diversity, behavioural disabilities, patients in hospitals, and inclusion of minorities.[1]

The main goals of the Working Group on Equity and Inclusion are to gather a community of experts that will identify and find solutions to challenges in accessibility in addition to compiling and developing new tools, online resources, and best practices to eventually propose formal declarations for the endorsement of the IAU.

The working group is collaborating closely with two IAU offices, the Office of Astronomy for Development and the Office for Astronomy Outreach. The work thus far has resulted in the traveling exhibit *Inspiring Stars* (Figure 2), an exhibit to promote the concept of "inclusion" at outreach, instructional, and professional levels. The exhibit also aims to broaden the horizons of children, parents, teachers and astronomers through showcasing assistive research tools for inspiring a love of science and the possibility of contributing to research in spite of apparent obstacles. Our work has also resulted in a dedicated IAU webpage to news, best practice guidelines, and resources for specific disabilities. One resource, for example, is the first comparative sign language dictionary for astronomical terms.

The working group organised a one-day meeting on astronomy and inclusion in 2016 in Colombia and this year we are organising a symposium in Tokyo, Japan titled Astronomy for Equity, Diversity and Inclusion. We will discuss best practices in accounting for disabilities; barriers to access; new technologies[2]; astronomy for society, sustainable development goals; the IAU100 perspectives on equity, diversity and inclusion; and diversity in research.

One of the outcomes of this meeting will be *The Mitaka Resolutions*. This document will describe a set of viewpoints and propose subsequent actions, in alignment with the new *IAU Strategic Plan 2020-2030* towards achieving higher levels of equity, diversity and inclusion in astronomy. The Mitaka Resolutions will be submitted to the IAU Executive Committee to be officially endorsed by the IAU General Assembly in Korea in 2021.

There are many challenges that we have to overcome in our goal to reach effective diversity and inclusion in science. To name a few, there are unconscious biases, hiring processes tailored for just part of the potential applicants, admission tests that are biased against women and minorities, physical barriers to access the scientific information, discomfort or interpersonal conflicts caused by diversity in groups, and many more (Miller et al., 2014; Plaut, 2014; Cooper, 2015; Moss-Racusina et. al., 2012; Dobbin et al., 2016; Welle et al., 2014; Amodio, 2014; Booksh et al., 2018). Many of these challenges were addressed at the firsti-inclusive astronomy meeting that was held at Vanderbilt University in the USA in 2015. The main outcome of the meeting were the *Nashville Recommendations for Inclusive Astronomy*, a document that was afterwards endorsed by the American Astronomical Society. Large astronomy projects are also incorporating inclusion policies and guidelines, like the creation of COINS (Committee On Inclusion iN SDSS) at the Sloan Digital Sky Survey.

We now have the responsibility to ensure inclusion and diversity are taken into account in how science will be made in the future. To accomplish this we already have tools like the *Nashville Recommendations* and the future *Mitaka Resolutions*, and specific working groups on astronomy and inclusion in some astronomical societies and projects. So, please remember: Diversity and inclusion foster excellence in science. Do not miss the chance to implement them in your institutions and research teams!

You can learn more about the IAU Working Group for Equity and Inclusion at http://sion.frm.utn.edu.ar/iau-inclusion/

Notes

1 Issues related to gender are covered by the IAU Working Group of Women in Astronomy.

2 These technologies include reading devices for the blind, 3D printers and thermal printers for the blind, tactile tablets, hearing aids for the deaf, software that translates spoken sentences into written ones, captioning technologies, online sign language dictionaries, adaptations of telescopes for people in wheelchairs, and so on.

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Biography

Amelia Ortiz-Gil is an astronomer working in outreach and education at the University of Valencia in Spain. She is an award-winning astronomy communicator, creating the groundbreaking “A Touch of the Universe” kit for the blind and visually impaired and tactile globes of the Moon, Mercury, Mars, and Venus (so far). She is the chair of the International Astronomical Union (IAU) Working Group of Astronomy for Equity and Inclusion and is the IAU National Outreach Coordinator for Spain.

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