SPACE+: Pathways for all Abilities

MULTIMODAL ANALYSIS AS A STEPPING STONE TOWARDS TRUE INCLUSIVITY

SAME TOOLS, SAME SPACE, SAME POSSIBILITIES

An interview with Beatriz Garcia
Scientific researcher at the Institute of Detection and Astroparticle Technologies in Argentina

Beatriz García is an astronomer and chair of the Astronomy for Equality, Inclusion, and Diversity working group of the International Astronomical Union (IAU) between 2015 and 2018. While building a successful career as a scientific researcher at the Institute of Detection and Astroparticles Technologies in Argentina researching high-energy particles and cosmic rays as part of the Pierre Auger and QUBIC collaborations, García is also advancing research in the field of multisensorial astronomy for accessibility, and currently leads several projects developing tools for multimodal data analysis such as the sonification tool sonoUno.

García also led the IAU Astronomical Terms for Sign Language project where an international comparative list of astronomical terms in sign language with some of the most commonly used astronomical terms, as well as new terms, were created together with the Blind and Visually Impaired (BVI) community. García found her passion for astronomy while reading Greek mythology and observing the sky with her naked eyes when she was young. Now she nurtures the passion for astronomy in high school students and shows them the power of space sciences.

In this interview, we conversed with García on the subject of accessibility in astronomy, the latest technological developments in the field, and the importance of real inclusivity in astronomy, in both the academic environment and work environment.

"This is real inclusion in my opinion – working together using the same tools in the same space, which ultimately means receiving the same possibilities, without marginalization."

UNOOSA: How did you get started with accessibility in astronomy and what draws your interest to the issue?

García: When you're studying the cosmos, and for instance working with gravitational waves, you are always working with things you cannot see, other examples are radio, microwaves, ultraviolet, x-rays, and more. In mainstream research, we are using data that can be interpreted with the eyes, even if you need to transform into visible, the invisible! It made me reflect on our visual interpretation of accessibility, for example on visually impaired people working in astronomy.

Also, during my career as a communicator in outreach, I have received many visitors who are blind or deaf. There were communication barriers and I realized that I had to do something about it.
I began to research new multimodal analyses of the data, for example, studying how the same data can be interpreted by hearing or touching. I started with the tactile models intended for blind people within the Equity, Inclusion, and Diversity Working Group of the IAU, and the models we developed are now used all over the world. It's amazing how everyone can now produce new tactile models with 3D printers, as these are great resources to communicate astronomy for visually impaired people.

After the tactile models, I started working with the sonification. Sonification means transforming an image into sound, or a set of data into sound, in order to make the analysis of the data, and then the research, more accessible for people who are visually impaired.

Working with tactile and thermal constellations, El Universo Invsisible exhibition, Mendoza, 2018. Credit: IteDAMendoza.

Another example of a tool for accessibility is the "thermal constellations", which uses temperature to explain not only the shape of the asterisms and the magnitude of the stars but also the colour meaning and the relationship with their surface temperature.

These kinds of accessible technologies are not only useful for persons with disabilities but can benefit everyone. From the moment we are born, we train our brains to interpret images. I believe we can only gain from using all the senses to approach nature. For instance, everyone should be trained to use sound as well as a plot to interpret signals.

> *"What makes me passionate about accessibility in astronomy is my core belief that everyone has the right to be part of the discovery. Sure, many persons with disabilities are involved in education and outreach activities, but our goal is to develop and use tools and devices to allow them to effectively work in astrophysics and be part of the discovery."*

What is one challenge that you face when communicating about your work?

Everybody can benefit from inclusivity and everybody can benefit from multiple ways of learning. However, one challenge is that not everyone believes this. If you speak to neurologists, for example, the conversation is easy because they understand that the detection of signals, features, etc., is possible using different parts of the brain. But when you talk about the same things with an astronomer, the discussion is not as simple. Astronomers will ask you to prove that this

is real. And so this is part of my research, to prove that you can detect things using different senses in a better way.

You are part of the QUBIC project that detects Cosmic Background Microwave (CMB) radiation. As the electromagnetic energy is outside the visible range, it seems like a good candidate for multimodal analysis as you described earlier. Could you tell us how the project is fostering accessibility?

This is a good starting point as it gives the opportunity to talk about detection beyond the visible. To explain how we transform signals into the visible, and how we can transform signals using other ways of representation, we are exploring the possibility to sonorize images, so the CBM, which is represented in images in false color, is part of the data able to be sonorized. We are also preparing 3D tactile models for example, which are ready to be installed at the visitor center in San Antonio de Los Cobres, Salta, near the site of the QUBIC Observatory.

> *"When you're studying the cosmos, and for instance working with gravitational waves, you are always working with things you cannot see."*

As the creator of the Astronomy for Equality, Inclusion, and Diversity working group at the IAU, you led several accessibility projects, such as the Astronomical Terms in Sign Language project, just to name one. How do you engage persons with disabilities in the development of accessible tools in astronomy?

Our approach is based on user-centered design. The idea is not to build what we want, but what is most useful for persons with disabilities. We always consult diverse persons during the development of a tool and in the feedback loop so that we can improve the proposal. For example, blind astronomers are a fundamental part of our team of developers. Developers can be both astronomers that have been blind since they were born, but also astronomers that have acquired the disability later in life. This participation is fundamental to getting an accessible product. We also include persons with disabilities in the testing groups and the focus groups. These can be people without expertise in astronomy as anyone can detect a signal, whether the signal is a star or a galaxy, or a gravitational wave.

Finally, we cooperate with volunteers from all over the world, of different ages, different cultures, and different backgrounds, working together on the development and testing of tools.

What are the main difficulties that you faced while developing tools for accessibility in astronomy? How did you overcome the challenges?

The main difficulty is that any project needs staff and enough grant money to pay people involved in the development of new tools. This is especially hard because most of the grants available are devoted to very well-established lines of research.

Inspiring Stars, Tactile Simulation Models in 3D, adapted from NASE Program, Japan, 2018. Credit: Tomita Akihiko

Moreover, for a new approach like multimodal analysis, we need more persons devoted full time to developing and testing the devices and tools. Innovation is a line of development that demands a lot of time and there will always be failures and not all people are ready or able to join.

> *"Everyone agrees that accessibility is a human right, however, getting the means to fund such project is not as easy as it should be. The importance and usefulness of research for accessibility should go without saying, but we often have to explain, more often than in other areas of research, why this type of development is as crucial and as worthy of funding as discovering a new galaxy or black hole."*

The good news is that in some countries, such as Argentina, the research in inclusion and assistive technologies are considered strategic topics and the Ministry of Science and Technology supports the activity with grants for Masters and Ph.D. students.

On the subject, I would like to thank UNOOSA, because the United Nations, through these kinds of interviews helps raise awareness and maintain interest in the topic of accessibility.

How can various groups of stakeholders encourage more inclusive education and increase meaningful engagement of persons with disabilities in astronomy?

Change comes slowly and from the combination of multiple factors. A good starting point would be education, at all levels and all formats, meaning both formal and non-formal education. To be interested in inclusivity research, one needs to be educated and have knowledge of the topic.

On one hand, professional studies and research on perception are needed. It is crucial to develop a strong theoretical framework through which constructs knowledge on the topic and demonstrates how this approach can broaden human potential.

On the other hand, people need to be stimulated in the use of all senses from childhood, through non-formal education. This way they will grow up to be comfortable using inclusive tools. Change should come from the governments, the education ministries, the education institutions, and the persons with disabilities included in the working groups on this topic.

The groups working in perception, disability, inclusion, and equity in all the fields of science, must try to include disabled people in their groups and use their experience and advice to produce good tools, devices, and resources and promote the achievement widely.

All scientists should consider including at least one activity, session, or workshop on inclusion during congresses or seminars and invite persons with disabilities to be part of the organization team.

Creating a Code of Conduct on the topic is also important. In 2021, the IAU published the "Springboard to Action: Recommendations for improving equity, inclusion, and Diversity in Astronomy", which is a good starting point.

You mentioned how hard it is to get funding for research. What do you think researchers can do to improve the probability of getting funding?

I would say it's the agencies who must do better in this case. For instance, by indicating in the bases for a grant the need to channel part of the money into accessibility projects. While offering special funds to research proposals on the topic for interdisciplinary teams would be a good thing, it is also necessary to prompt researchers involved in any project to take action toward accessibility.

Additionally, part of the grants must be devoted to outreach, which some years ago did not even exist. Stakeholders understand that communication with the public is part of scientific activity, however, they need to take one step further and show that inclusion is also an important part of our job as educators and scientists.

First Inspiring Stars exhibition at the IAU General Assembly, Vienna 2018. Credit: IAU.

> *"Persons with mobility disabilities or neurodiverse persons still face issues entering the astronomy field. We have made some progress, but we are still far from full inclusivity."*

What more needs to be done to encourage funding providers to make grants to accessibility projects? What is required to make a mindset shift?

We need more people involved in spreading the word, showing the importance of the developments in the field, participating in conferences, workshops, and public audiences, speaking with politicians, participating in TV, radio, and newspapers spaces, and also acceding to decision-making positions within organizations.

Would you say astronomy as a field of study and employment is becoming more inclusive?

Yes, it's becoming more inclusive, but slowly and not in every field. Complete inclusivity in institutions has not been achieved. For instance, there are still research centers and even university laboratories that don't feature wheelchair access. Persons with mobility disabilities or neurodiverse persons still face issues entering the astronomy field. We have made some progress, but we are still far from full inclusivity.

We should work forward to a future where persons with disabilities can have the same possibilities that able-bodied people have. Each day, there are more and more people that understand the situation, and more and more people join the groups working in inclusion. However, the groups working on inclusion are still not so numerous. There are groups in almost every country, but they are not very visible. Our job is not just to produce the tool, but to also show that the tool is important and spread awareness on the subject. This is a line of development that demands a lot of time, effort, and a lot of failures, but it is ultimately useful and very important, as it allows persons with disabilities to work in science.

Interest in astronomy can start as soon as kindergarten, and it develops in school and university. What can educators do to encourage interest in space in persons with disabilities and mainstream the idea of disability in space?

I think the educators in the first levels of education, kindergarten, and primary school mainly, and afterward secondary and high school, are crucial for the students in the selection of a career and in the understanding of science. We need a population who understands science. And this will only be possible if the teachers and professors at the first level of education know science and how to teach it.

For this reason, we work with teachers and make efforts to train teachers, giving classes in school, or making workshops. It's easy to make students interested in science with practical workshops and little simple and inexpensive experiments. With a telescope, you can make observations even during the school day, in plain sunlight. Many different projects can be performed in the school during the day, for example trying different ways

of measuring the dimensions of the Earth. It's important to show how powerful science is and how you can do science at home, at school, and even on the street. Teachers need to convey the message that science is everywhere and you can make a "laboratory" anywhere, even just by measuring the size of the Earth using a stick and its shadow, amazing!

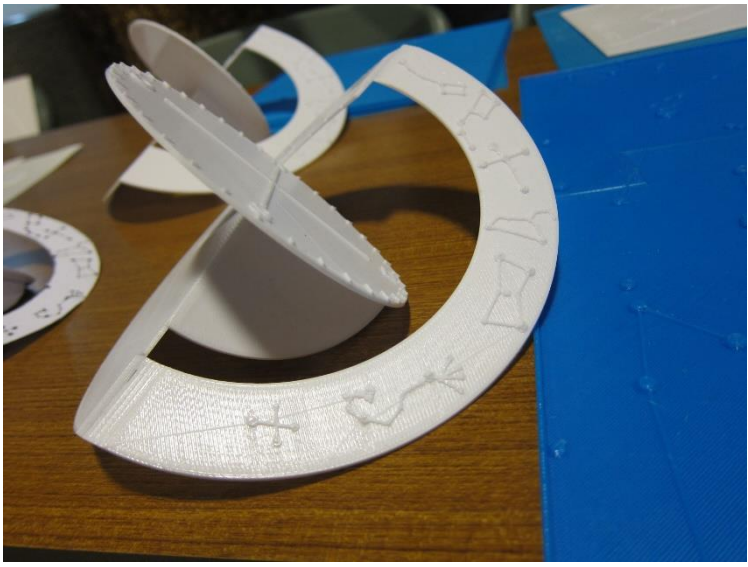
Another good way to promote science is to celebrate international days, weeks, or years dedicated to science. To give an example, May 16, the International Day of Light is a great opportunity to speak about what light is, the science behind it, and how you can study it and work with it. Another occasion worth celebrating in class is The International Day of the Woman and Girls in Science and Technology.

For high school students, I saw how multimedia activities are those that spike the greatest interest, as well as the use of informal education activities such as visits to planetariums. Instead of giving the students a questionnaire to fill out, or just materials to read, you'll get the best reactions by asking them to participate in a workshop or carry out a small experiment and share the results with other students in the world.

Can you give some pieces of advice to persons with disabilities who want to pursue an education or employment in the field of astronomy?

I am completely convinced that there is no such thing as a vocation. I believe that people can be whatever they want to be. To be an astronomer, you don't really need any specific set of skills. Many think you need to be book-smart to be an astronomer, but I say anyone is clever enough to thrive in science.

If you are interested in life, how nature functions, and how the planets came to be the way they are, then astronomy is a good choice because astronomy is a discipline that is connected to everything, not just stars and galaxies. Many people who are today affirmed in the field of astronomy were not academically gifted throughout the school. The only thing you need to become an astronomer is an interest in and passion for outer space.



Inspiring Stars. Tactile Simulation Models in 3D (detail), adapted from NASE Program, Japan,2018
Credit: Tomita Akihiko

I found my passion for space when I was very young, reading Greek mythology and trying to identify constellations with the naked eye. Not everyone shares the same path, but if you're interested in nature and understanding life, you might be an astronomer in the making.

> *"Science is made of bricks. Each one of us puts a brick on the wall, and together we are constructing a big building called science. What we did in the past is important for the present, and all the things we did in the past and do in the present will be important for the future."*

The message that I want to transmit to young people is that anyone can be what they want to be. One may feel disappointed if faced with objection from the family regarding one's education or career choice or feel tired and a sense of loss of hope when faced with many difficulties. *But my suggestion is to never stop believing that it is possible to have a career in science. It's difficult. It's very hard, as with everything in life. But along the way, probably now more than in the past, you will find someone who is ready to help. Also, what is most important is that we are working on something that is important, we are passionate about the things we are doing, and we are happy doing the job. And I think this is more important than a big salary or even fame.*

What are your plans for the future?

At the moment, my main goal is to involve more people in inclusivity projects and get more people interested in the subject at large. We need to prove that our research in the field is important and can be useful to everyone in astronomy. For this reason, we are now in the phase of developing simulations. Then we'll need to use databases to try and extract data and further research in the field. Remember that we need to prove to the community that the multimodal analysis of data improves scientific research.

Also, it would be crucial to develop and train Virtual Assistants as an extra aid to persons with disabilities. Visually impaired persons and people who have mobility impairments could especially benefit from the help of properly trained virtual assistants that can be activated in different ways and can interpret not just voices, but texts, gestures and then, and Sign Language.

At the same time, I will keep working in the field of Cosmology and especially on the QUBIC project. We are now in the testing phase of the instrument, which will probably take another 2 or 3 years to produce valuable results. ■

The term "astronomy" as represented in sign language in different countries. Credit: IAU.

BIO

Beatriz García is a scientific researcher at the Institute of Detection and Astroparticle Technologies in Argentina. She is a member of international collaborations at the Pierre Auger Observatory (for the detection and study of ultra-high energy cosmic rays) and the QUBIC Project (for the study of cosmic background radiation and verification of the appearance of primordial gravitational waves at the time of the inflation of the Universe). She was president of Commission 1 of the International Astronomical Union (2015-2018) and creator of the Astronomy for Equality, Inclusion, and Diversity working group of the commission. She is also a teacher and scientific disseminator. She has been dedicated to the design and development of tools for a multi-sensory approach to the study of nature for more than a decade.

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RESOURCES

- IAU Executive Committee Working Group Astronomy for Equity and Inclusion
- IAU Astronomy for Equity and Inclusion News
- The IAU inclusive world exhibition
- Examples of tactile models:
  - A giant stars chart
  - The constellation of the zodiac
- LightSound and the Orchestar
- sonoUno
  - Download the GitHub code for sonoUno

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