ASTRONOMY FOR ALL

Advancing Diversity, Equity, and Inclusion within the Chilean astronomical community

SONIFICATION FOR RESEARCH: MAKING ASTRONOMY ACCESSIBLE TO ALL

BIO INSTITUTO DE BIOINGENIERÍA

UM UNIVERSIDAD DE MENDOZA

UTN FACULTAD REGIONAL MENDOZA
UNIVERSIDAD TECNOLÓGICA NACIONAL

CONICET

sonoUno

Fundación Albedo 0.39

OUR TEAM

Johanna Casado

Beatriz García

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OUR TEAM

SONIFICATION

Equity and inclusion on research

- **Functional diversity**
  - Different sensory styles for accessing knowledge
- **Digital systems**
  - User centred design in HCI (Human Computer Interface)
- **Multimodal display**
  - Sonification to astronomical data sets

SONIFICATION

The International Community for Auditory Display (ICAD) defines sonification as "the use of non-speech audio to convey information". This definition emphasizes that sonification is a tool for communication/understanding of the world, not simply the production of sound.

SONIFICATION

Sonification parameters:

- **Pitch**: perceived highness or lowness of a sound.
- **Amplitude**: intensity or volume of a sound.
- **Timbre**: The quality of a sound that distinguishes it from others with the same pitch and loudness.
- **Duration**: The length of a sound.
- **Spatialization**: The perception of the location or movement of a sound source in space.

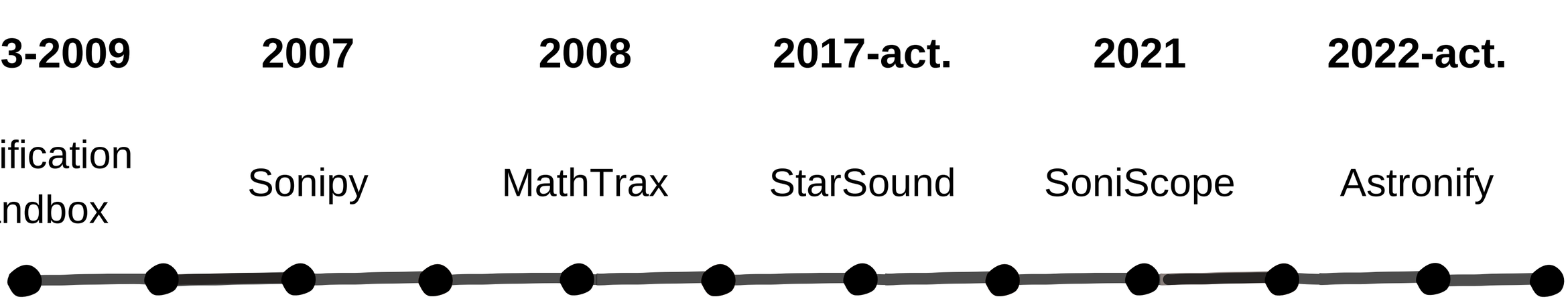
BACKGROUND

The majority of current research on multimodal information presentation focuses on complementing visualization, often presented or evaluated with non-disabled participants. Also, it is often developed for outreach, without considering a standardized approach for wider use.

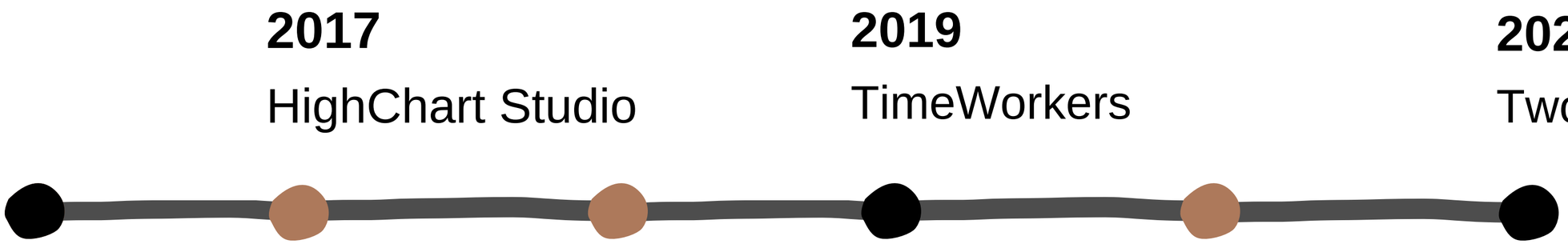
BACKGROUND

In the last decade, there has been a significant surge in the number of projects employing sonification to represent astrophysical data. **Zanella et al. (2022)** documented 98 sonification projects developed since 1962, many of which have been discontinued, lack proper documentation, or demonstrate no scientific application. Notably, nearly 80% of these projects were undertaken between 2011 and 2021. Furthermore, these projects exhibit diverse objectives: some focus on **command-line sound generation**, others prioritize **user customization of sound configurations**, and others emphasize the development of **accessible graphical interfaces**.

SOME DESKTOP TOOLS



SOME WEB TOOLS



PERCEPTION

Tucker Brown et al. (2022) uses the software Astronify to study light curves. Results showed that experts perform better with plots; on the other hand, experts and non-experts present no difference using sonification.

Using STRAUSS, **Trayford et al. (2023)** presented the use of spectra sonification to evaluate if participants could rate some physical properties. Under 58 respondents, the ratings present a relevant correlation. The authors express that, given the minimal training and small sample, these are very promising results.

REMEMBER

Sonification parameters:

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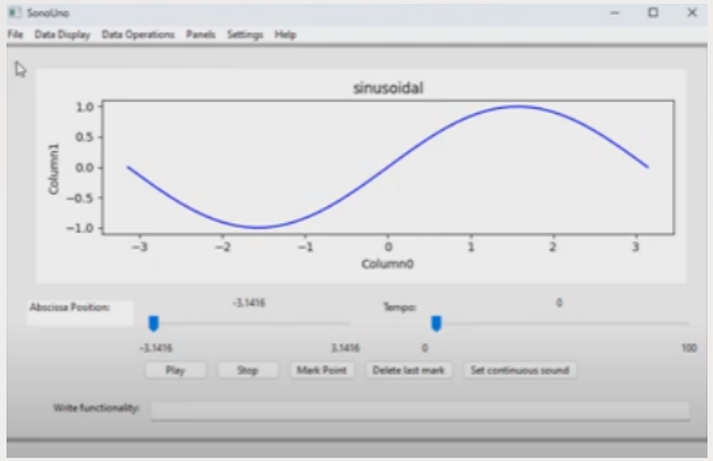
SONIFICATION AND VISUALIZATION

Domain	Substrate	Mark types	Possible channels
Visualization	Space	0D: Point	position, size, color hue,...
		1D: Line	
		2D: Area	
		3D: Volume	
Sonification	Time	0D: State in time	pitch, loudness, timbre,...
		1D: Development over time	

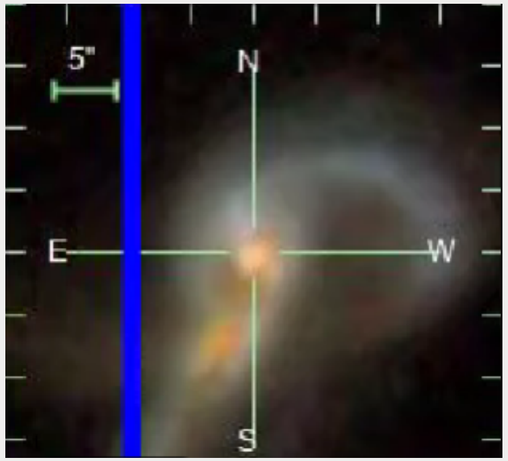
Extracted from Enge, K., Rind, A., Iber, M., Höldrich, R., & Aigner, W. (2023). Towards a unified terminology for sonification and visualization. Personal and Ubiquitous Computing, 27(5), 1949-1963. DOI: 10.1007/s00779-023-01720-5

DISPLAYS AND TECHNIQUES

Cartesian plot

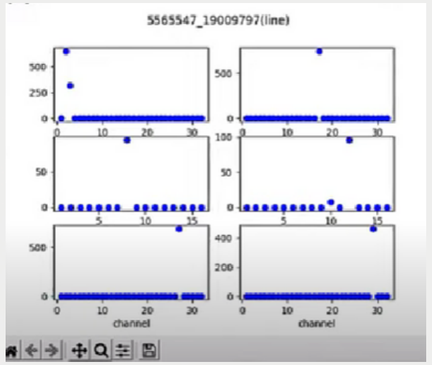


Images



Light/Color to sound

Specific fenomena



HOW TO THINK SONIFICATION?

- What are the possible sound parameters?
- What is the information to share?
- For multimodal designs, ensure synchronization and semantic consistency across sensory modalities.

ABOUT SONOUNO

User testing

FOCUS GROUP

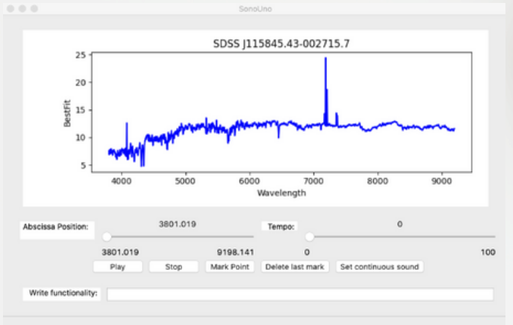
- Memory overload
- Information needs
- Needs to choose
- Training needs
- Social aspects

EMAIL CONTACT

- Recommendations list
- Improvements by group

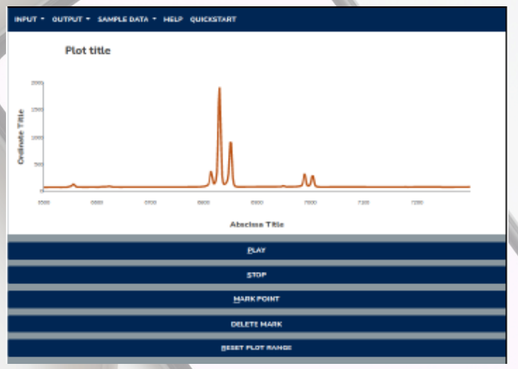
Tools

DESKTOP



SCRIPTS

WEB

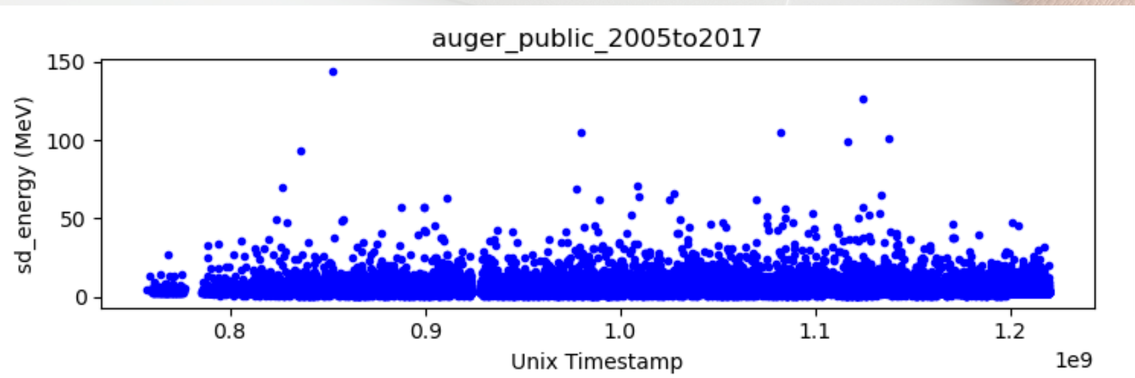


Applications with real data

- **“Pierre Auger - Open Data”**

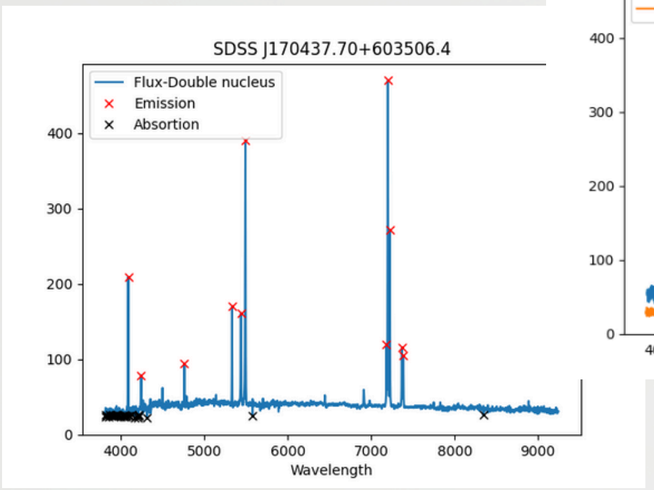
Cosmic Rays

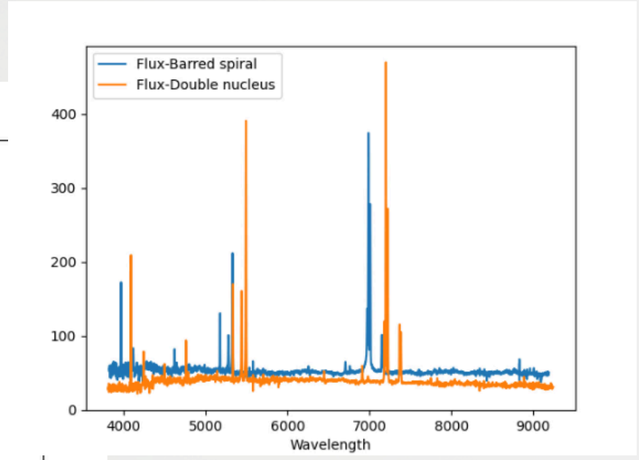
Important links

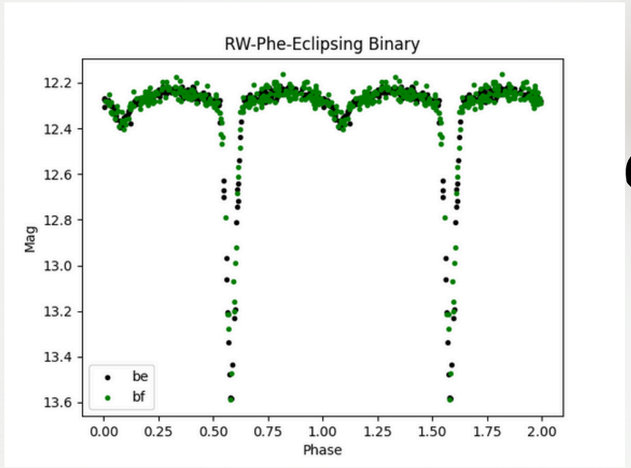


- **“Sloan Digital Sky Survey”**

Galaxy spectra





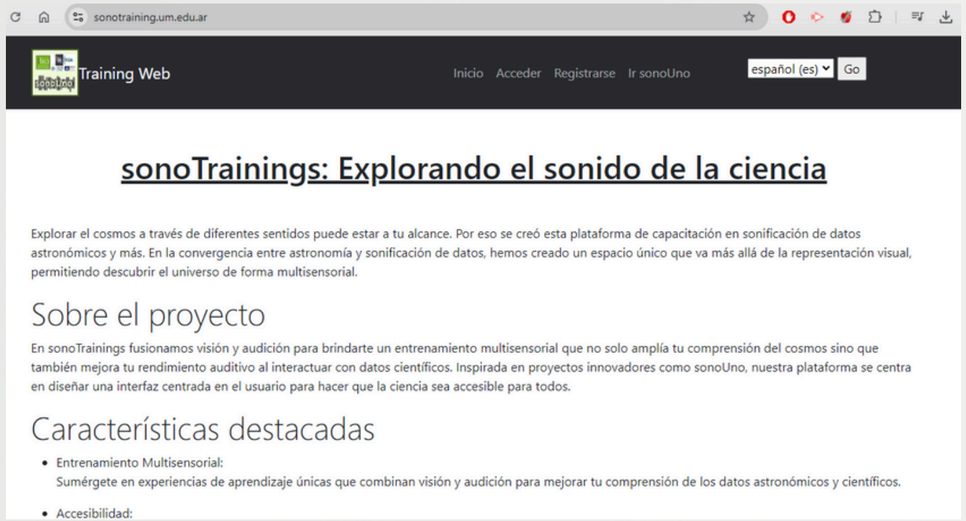


- **“ASAS-SN”**

Variable stars

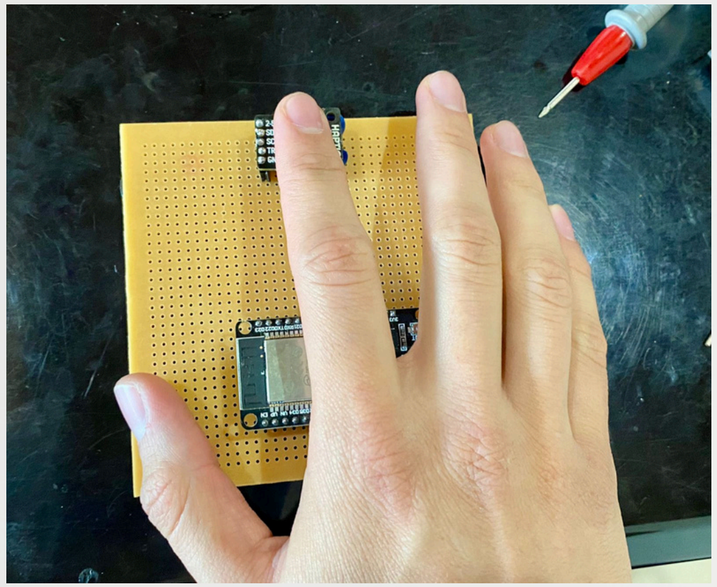
Actual research lines

- Perception analysis
  - Multimodal analysis course
  - Training web platform (https://sonotraining.um.edu.ar/)
  - One doctoral student



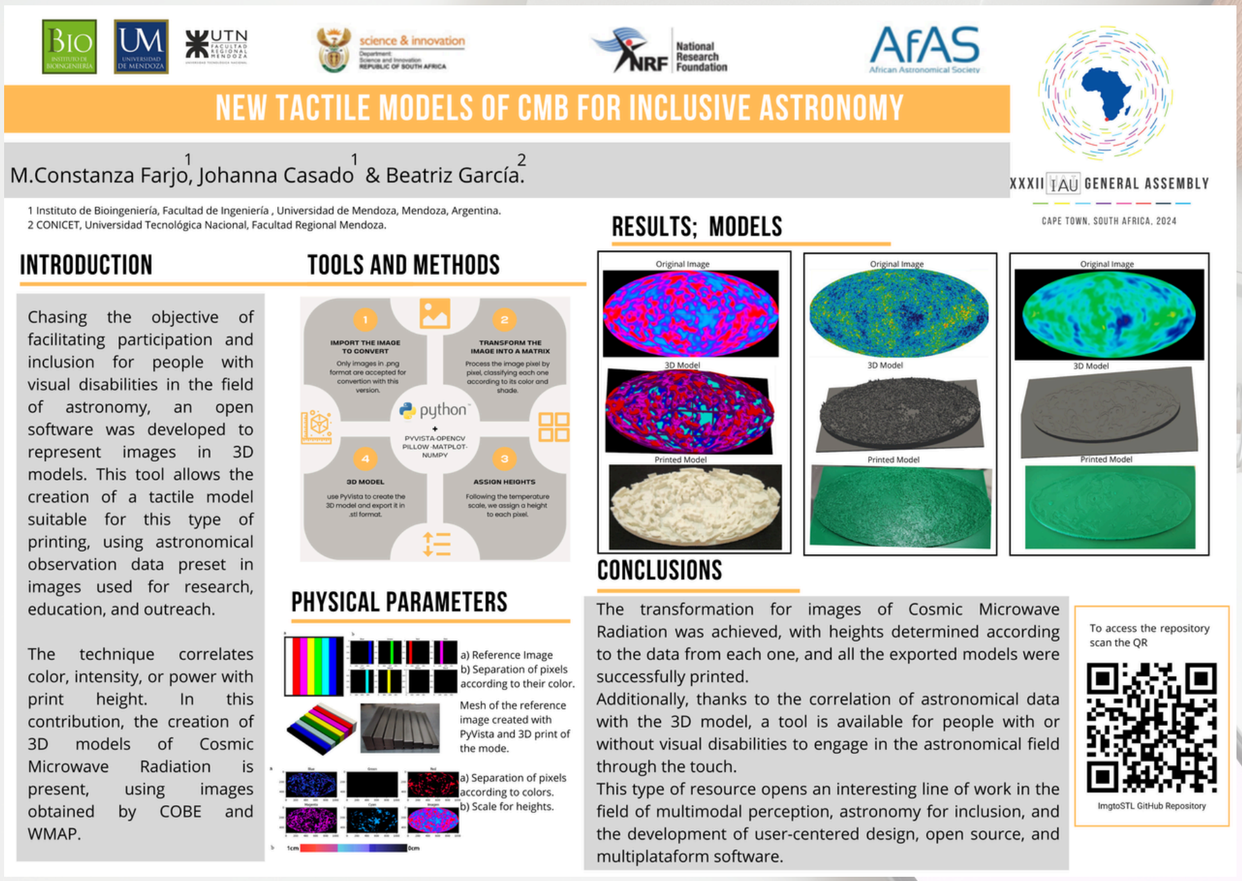
Actual research lines

- New Techniques on User Centred Design
  - One degree thesis on UCD
  - Other about haptic posibilities



Actual research lines

- Multimodal analysis (1 grade student)
  - 3D model generation



NEW TACTILE MODELS OF CMB FOR INCLUSIVE ASTRONOMY

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2 CONICET, Universidad Tecnológica Nacional, Facultad Regional Mendoza.

XXXII IAU GENERAL ASSEMBLY
CAPE TOWN, SOUTH AFRICA, 2024

INTRODUCTION

Chasing the objective of facilitating participation and inclusion for people with visual disabilities in the field of astronomy, an open software was developed to represent images in 3D models. This tool allows the creation of a tactile model suitable for this type of printing, using astronomical observation data preset in images used for research, education, and outreach.

The technique correlates color, intensity, or power with print height. In this contribution, the creation of 3D models of Cosmic Microwave Radiation is present, using images obtained by COBE and WMAP.

TOOLS AND METHODS

1 IMPORT THE IMAGE TO CONVERT
Only images in .png format are accepted for convertion with this version.

2 TRANSFORM THE IMAGE INTO A MATRIX
Process the image pixel by pixel, classifying each one according to its color and shade.

python
+
PYVISTA·OPENCV
PILLOW·MATPLOT·
NUMPY

4 3D MODEL
use PyVista to create the 3D model and export it in .stl format.

3 ASSIGN HEIGHTS
Following the temperature scale, we assign a height to each pixel.

PHYSICAL PARAMETERS

a) Reference Image
b) Separation of pixels according to their color.

Mesh of the reference image created with PyVista and 3D print of the mode.

a) Separation of pixels according to colors.
b) Scale for heights.

RESULTS; MODELS

Original Image
3D Model
Printed Model

CONCLUSIONS

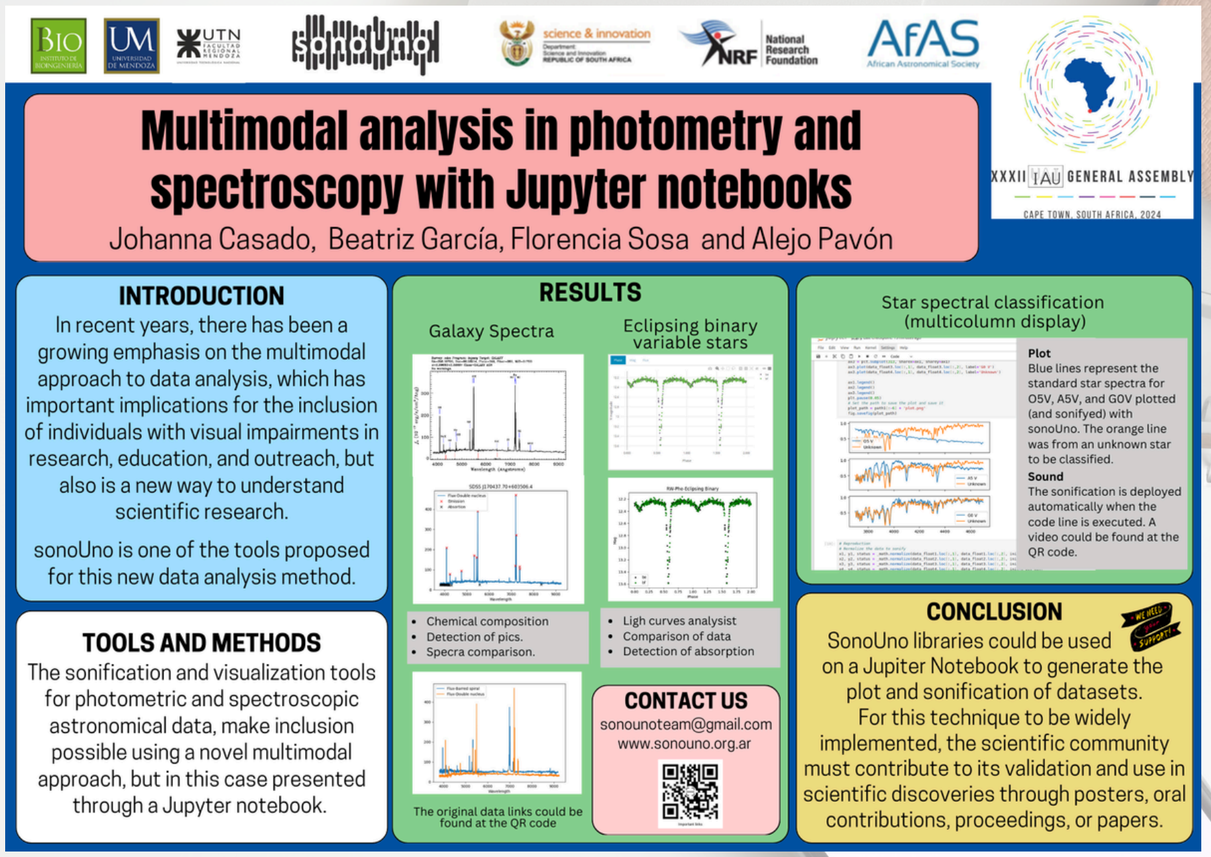
The transformation for images of Cosmic Microwave Radiation was achieved, with heights determined according to the data from each one, and all the exported models were successfully printed.
Additionally, thanks to the correlation of astronomical data with the 3D model, a tool is available for people with or without visual disabilities to engage in the astronomical field through the touch.
This type of resource opens an interesting line of work in the field of multimodal perception, astronomy for inclusion, and the development of user-centered design, open source, and multiplataform software.

To access the repository scan the QR

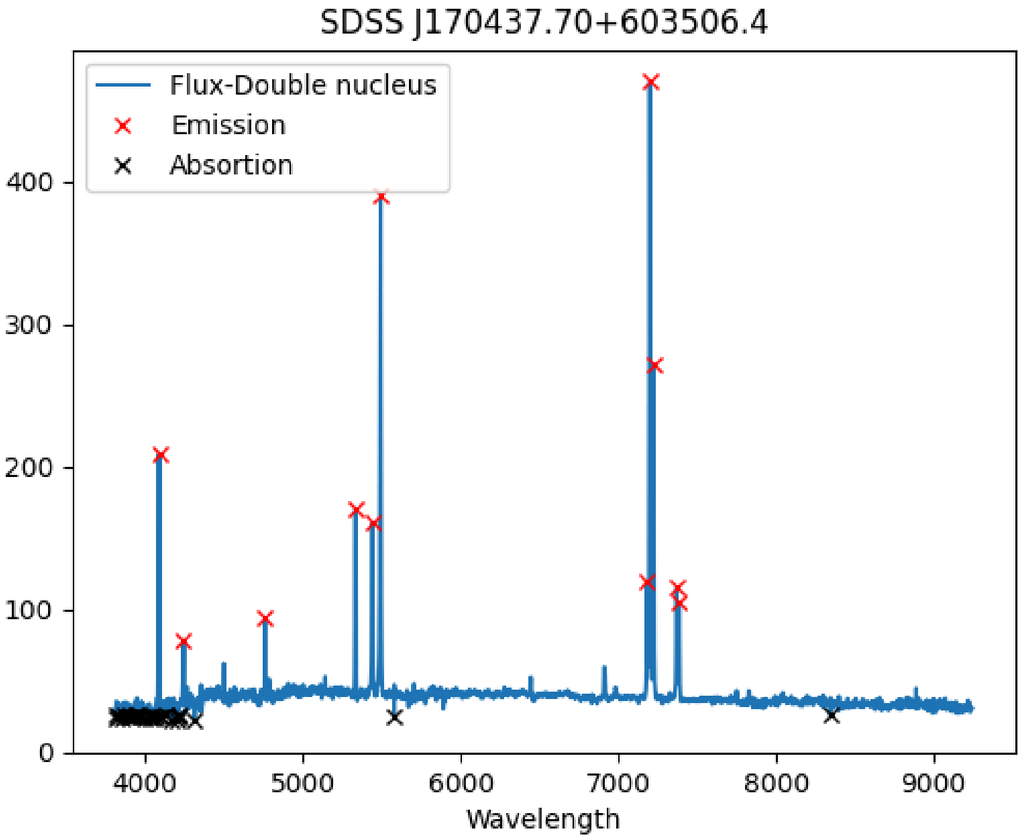
ImgtoSTL GitHub Repository

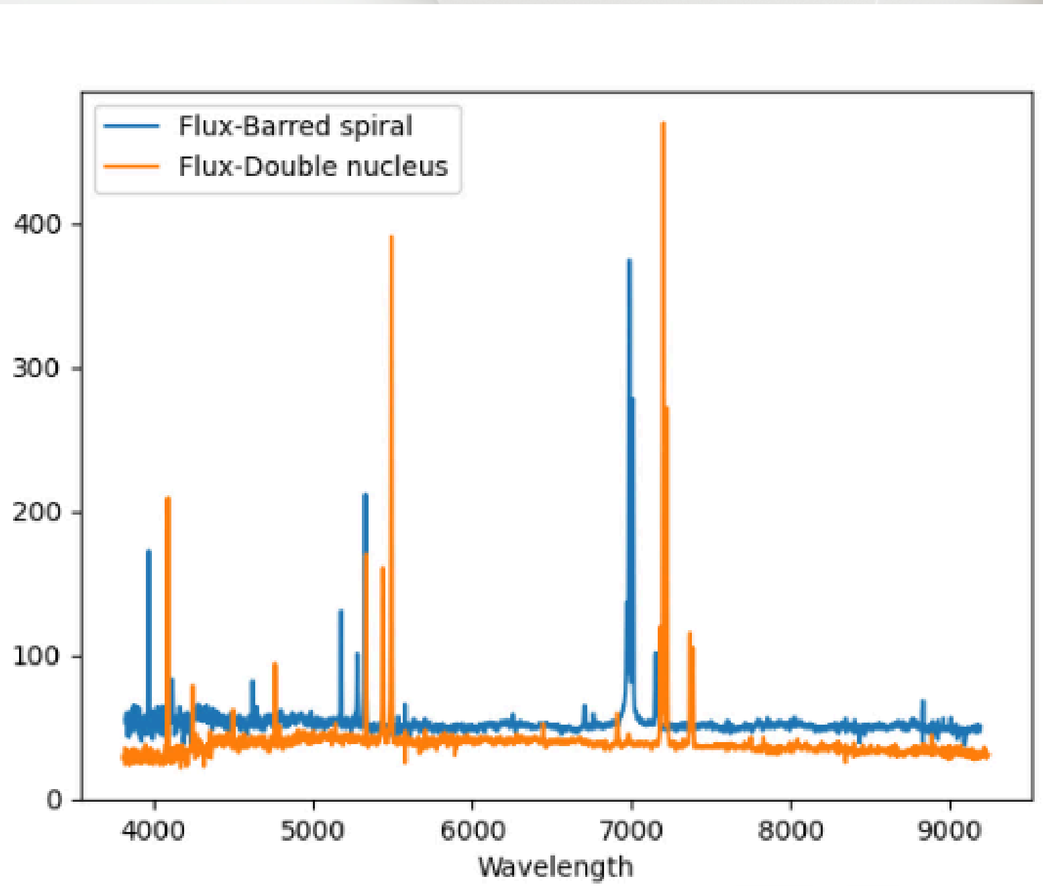
Actual research lines

- Sonification applied to specific data sets and data analysis (2 grade students)
  - Galaxy spectra
  - Star classification

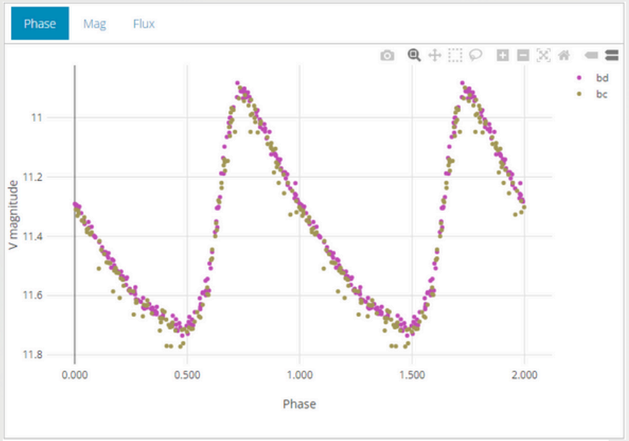


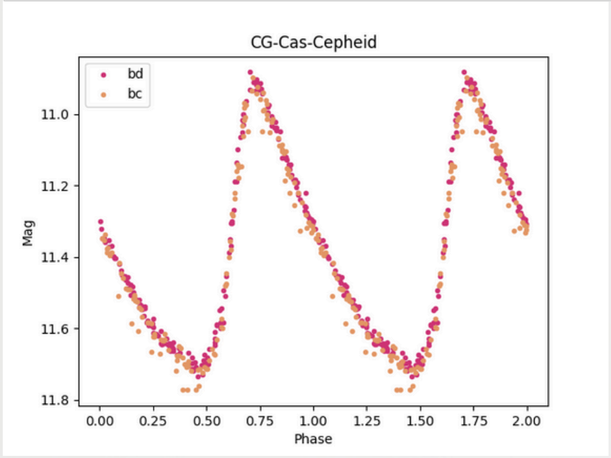
Galaxy spectra (peaks and comparison)





Light curves (Phase diagram)

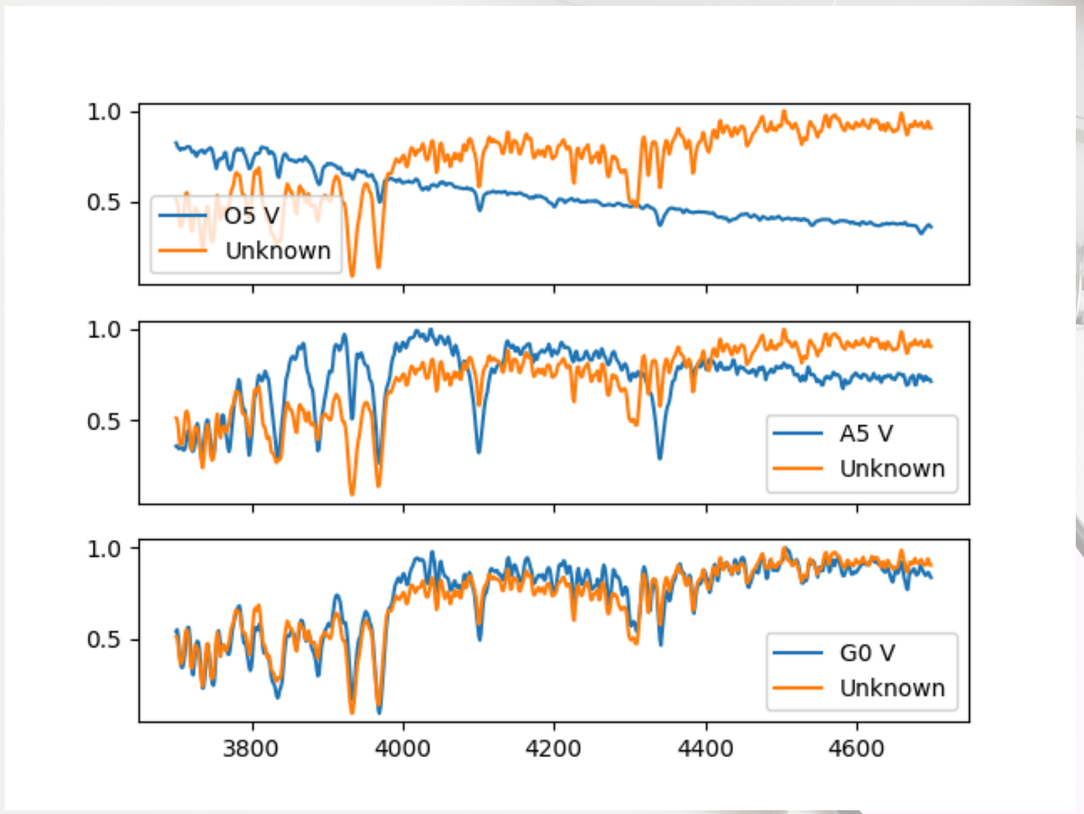




SonoUno links

Important links

Star classification



CONCLUSION

Returning to the framework and the question of how to think about sonification, the technology and techniques available today allow us to think of more inclusive ways to deploy information using the different sensory styles that a person possesses. By presenting the same information through visualization, sonification, and touch, we ensure that each individual can access the same information even when they lack a certain sensory style.

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THANK YOU

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