

ASTRONOMY FOR ALL

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



SONIFICATION FOR RESEARCH: MAKING ASTRONOMY ACCESSIBLE TO ALL



Fundación
Albedo
0.39



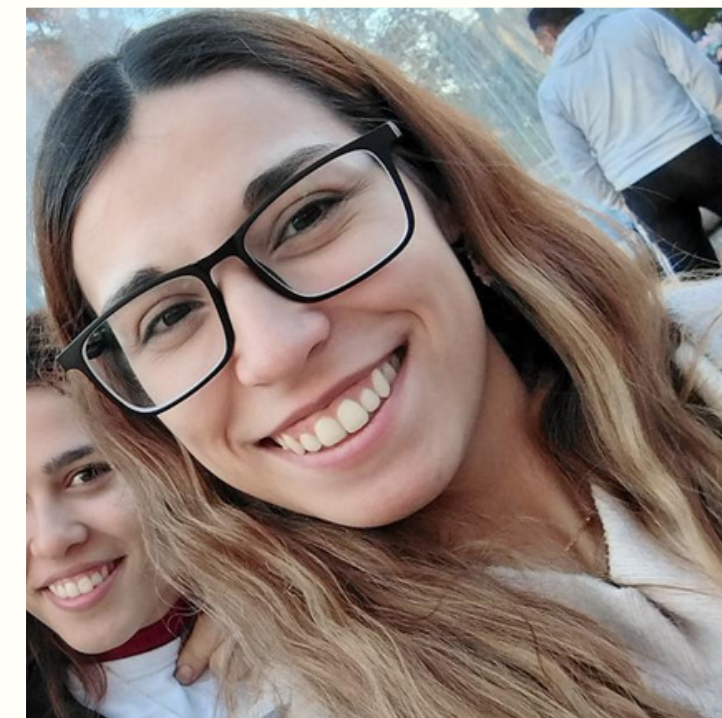
OUR TEAM



Johanna Casado



Beatriz García



Natasha Bertaina

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:

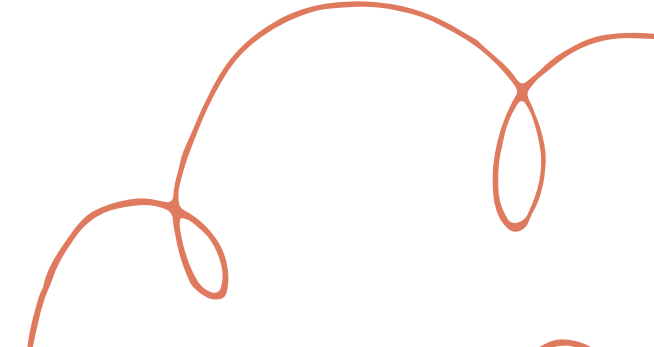

- **Pitch:** perceived highness or lowness of a sound.
- **Amplitude:** intensity or volume of a sound.
- **Timbre:** The quality of a sound that distinguishes it from others with the same pitch and loudness.
- **Duration:** The length of a sound.
- **Spatialization:** The perception of the location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

2003-2009

2007

2008

2017-act.

2021

2022-act.

Sonification
Sandbox

Sonipy

MathTrax

StarSound

SoniScope

Astronify

2006-2011

2008

2017

2017-act

2020-2021

2021-act.

xSonify

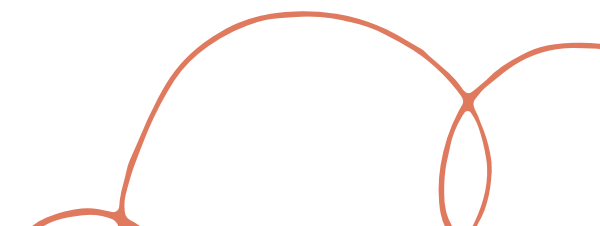
SonifYer

Planethesizer

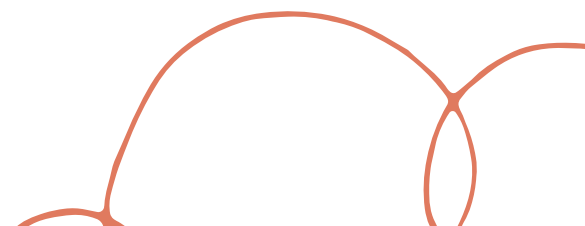
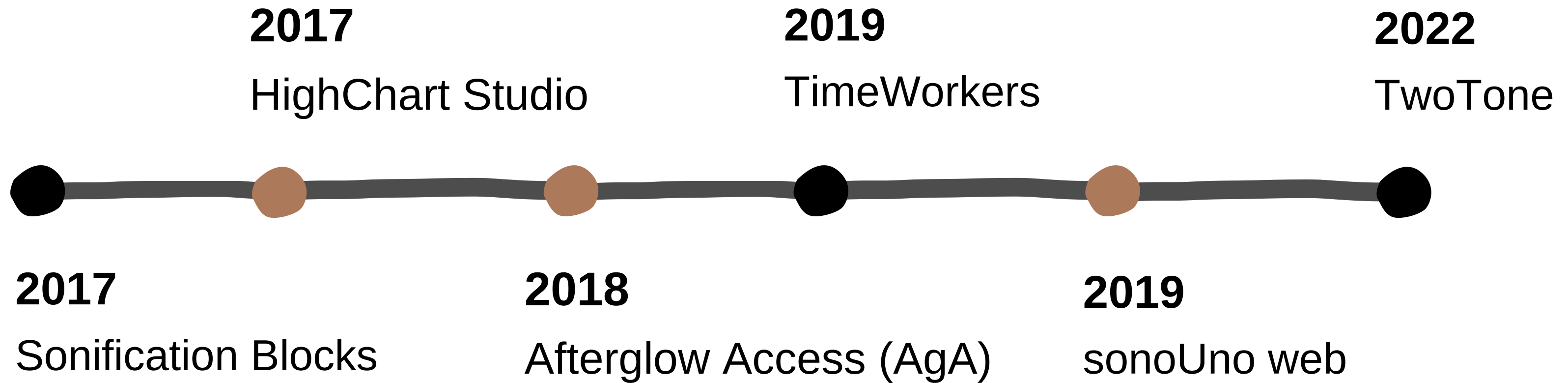
sonoUno

Soni-py

STRAUSS



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:

- **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.
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SONIFICATION AND VISUALIZATION

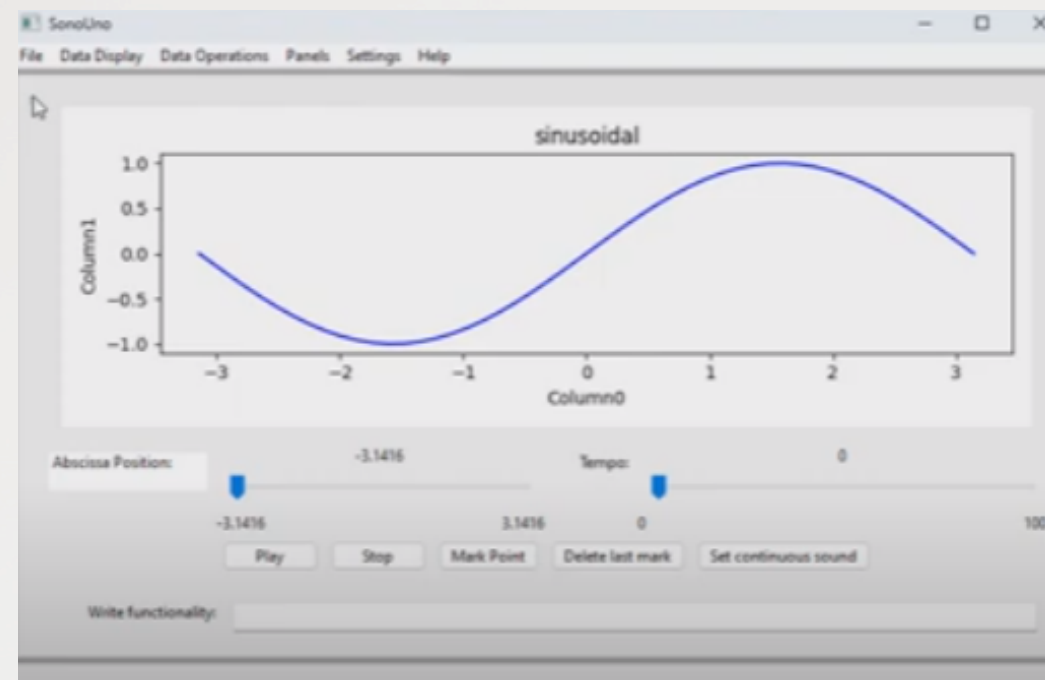
Domain	Substrate	Mark types	Possible channels
Visualization	Space	0D: Point 1D: Line 2D: Area 3D: Volume	position, size, color hue,...
Sonification	Time	0D: State in time 1D: Development over time	pitch, loudness, timbre,...

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

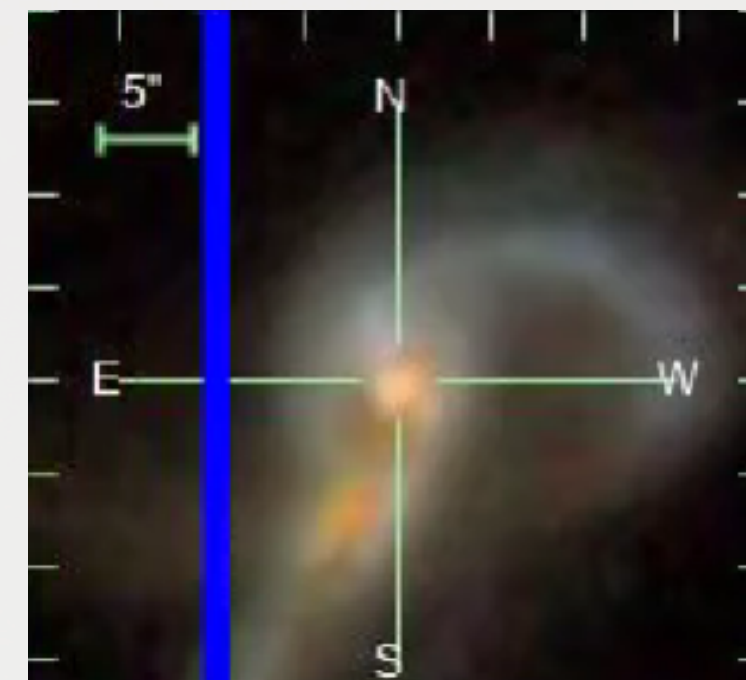
DISPLAYS AND TECHNIQUES



Cartesian plot



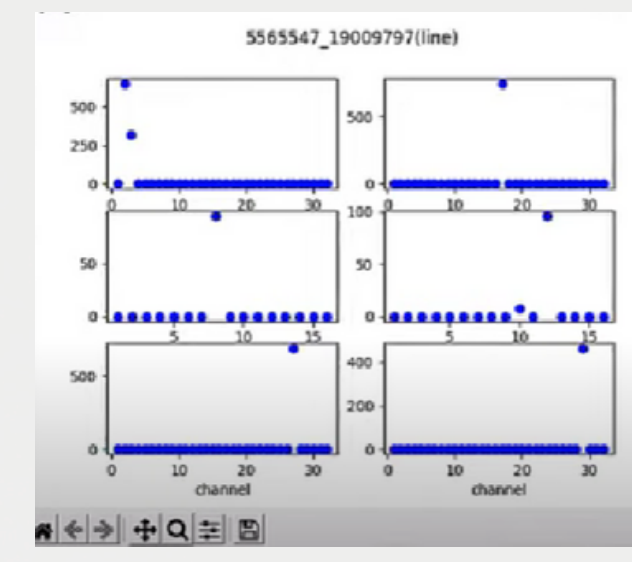
Images



Light/Color to sound



Specific phenomena





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

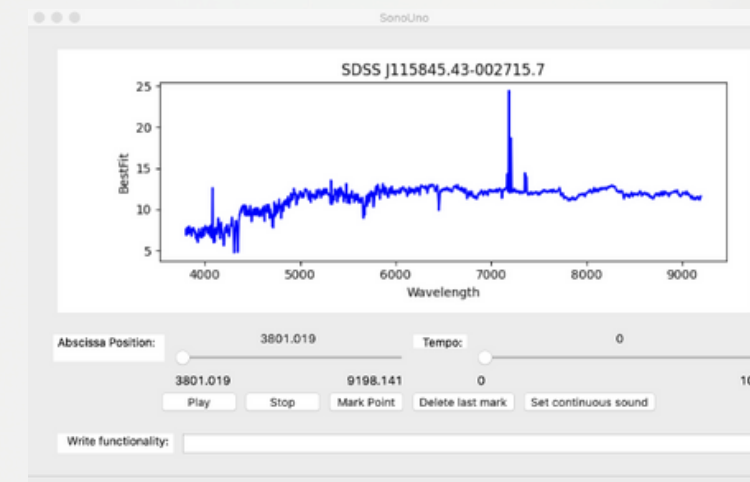
- Memory overload
- Information needs
- Needs to choose
- Training needs
- Social aspects

EMAIL CONTACT

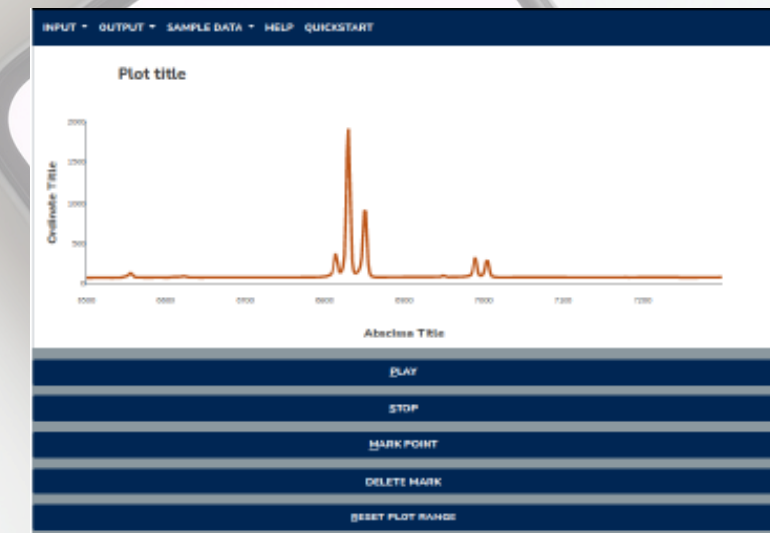
- Recommendations list
- Improvements by group

Tools

DESKTOP



WEB

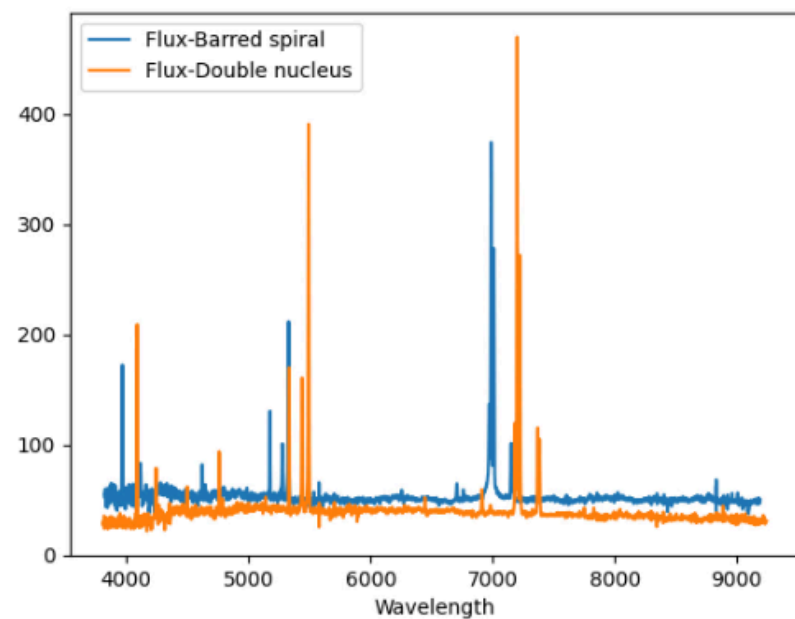
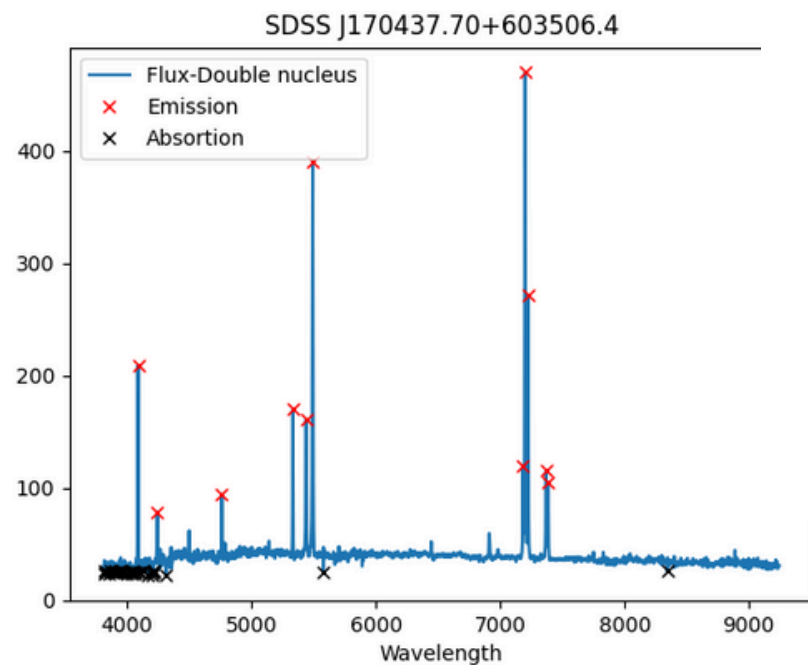


SCRIPTS

Applications with real data

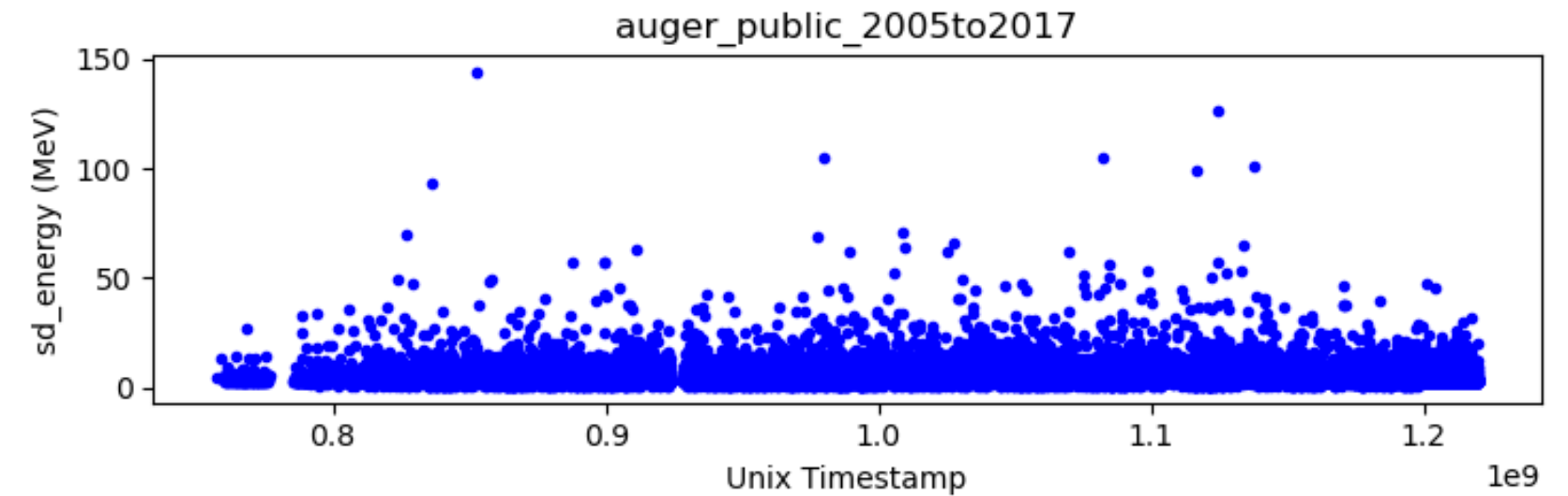
- “Sloan Digital Sky Survey”

Galaxy spectra



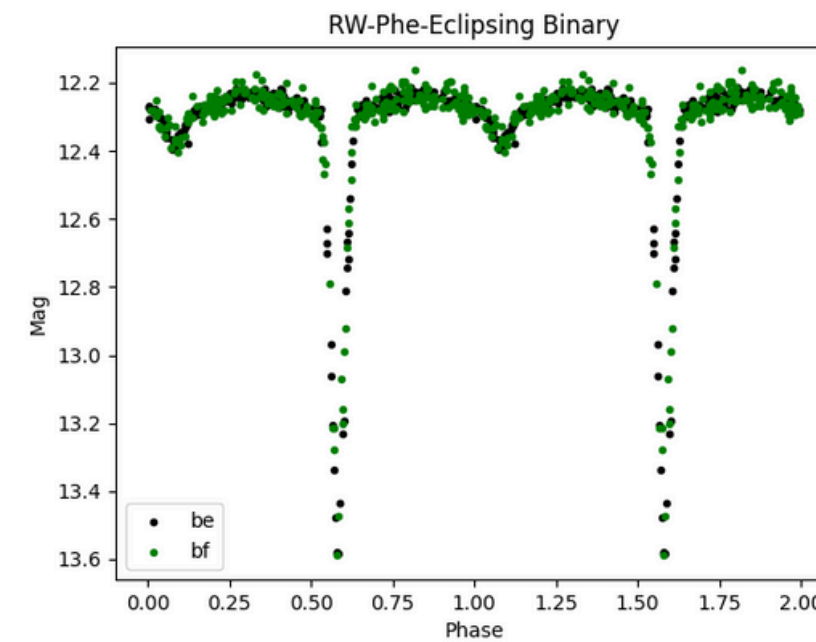
- “Pierre Auger - Open Data”

Cosmic Rays




- “ASAS-SN”

Variable stars



Actual research lines

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



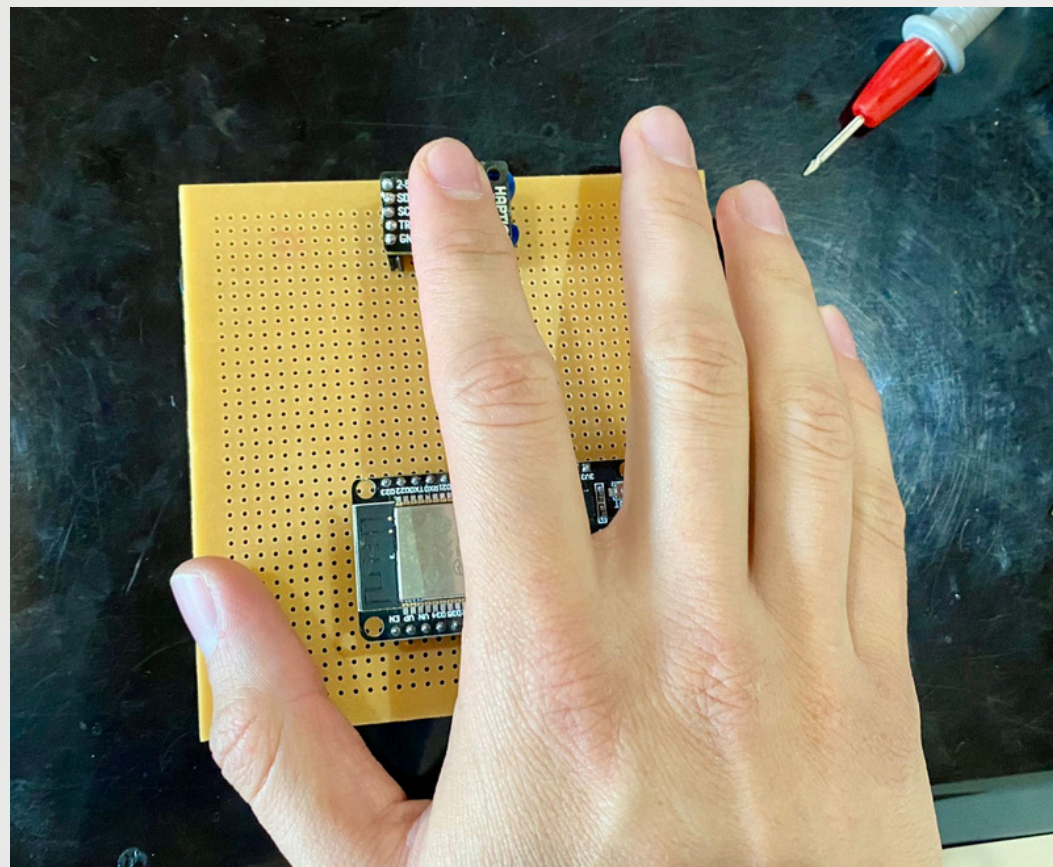
The screenshot shows the website's header with navigation links: Inicio, Acceder, Registrarse, Ir sonoUno, and a language selector for español (es). The main heading is **sonoTrainings: Explorando el sonido de la ciencia**. Below it, a paragraph explains the platform's purpose: "Explorar el cosmos a través de diferentes sentidos puede estar a tu alcance. Por eso se creó esta plataforma de capacitación en sonificación de datos astronómicos y más. En la convergencia entre astronomía y sonificación de datos, hemos creado un espacio único que va más allá de la representación visual, permitiendo descubrir el universo de forma multisensorial." The page also includes sections for "Sobre el proyecto" and "Características destacadas", which lists "Entrenamiento Multisensorial" and "Accesibilidad".





Actual research lines

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



sonoUno web

Abrir Guardar Datos Ayuda

Nombre del gráfico

Posición del eje X

Tempo

CONFIGURACIONES

GRÁFICO

CONFIGURACIONES GENERALES

- Grilla
- Escala de grises
- Rotar eje X
- Rotar eje Y

COLOR

- Azul
- Rojo
- Verde

ESTILO DE LÍNEA

- Sólida
- Punto
- Guión-punto

Actual research lines

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

BIO INSTITUTO DE BIOINGENIERIA
UM UNIVERSIDAD DE MENDOZA
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science & innovation Department of Science and Innovation REPUBLIC OF SOUTH AFRICA
NRF National Research Foundation
AFAS African Astronomical Society
XXXII IAU GENERAL ASSEMBLY CAPE TOWN, SOUTH AFRICA, 2024

NEW TACTILE MODELS OF CMB FOR INCLUSIVE ASTRONOMY

M.Constanza Farjo,¹ Johanna Casado¹ & Beatriz García.²

¹ Instituto de Bioingeniería, Facultad de Ingeniería, Universidad de Mendoza, Mendoza, Argentina.
² CONICET, Universidad Tecnológica Nacional, Facultad Regional Mendoza.

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

- IMPORT THE IMAGE TO CONVERT**
Only images in .png format are accepted for conversion with this version.
- TRANSFORM THE IMAGE INTO A MATRIX**
Process the image pixel by pixel, classifying each one according to its color and shade.
- ASSIGN HEIGHTS**
Following the temperature scale, we assign a height to each pixel.
- 3D MODEL**
Use PyVista to create the 3D model and export it in .stl format.

python
PYVISTA, OPENCV, PILLOW, MATPLOTLIB, NUMPY

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 (three columns showing different color mappings and their corresponding 3D and printed models)

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 multiplatform software.

To access the repository scan the QR
ImtoSTL GitHub Repository

Actual research lines

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

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science & innovation Department of Science and Innovation REPUBLIC OF SOUTH AFRICA
NRF National Research Foundation
AfAS African Astronomical Society

XXXII IAU GENERAL ASSEMBLY
CAPE TOWN, SOUTH AFRICA, 2024

Multimodal analysis in photometry and spectroscopy with Jupyter notebooks

Johanna Casado, Beatriz García, Florencia Sosa and Alejo Pavón

INTRODUCTION

In recent years, there has been a growing emphasis on the multimodal approach to data analysis, which has important implications for the inclusion of individuals with visual impairments in research, education, and outreach, but also is a new way to understand scientific research.

sonoUno is one of the tools proposed for this new data analysis method.

RESULTS

Galaxy Spectra

Eclipsing binary variable stars

Star spectral classification (multicolumn display)

Plot
Blue lines represent the standard star spectra for OSV, A5V, and G0V plotted (and sonified) with sonoUno. The orange line was from an unknown star to be classified.

Sound
The sonification is deployed automatically when the code line is executed. A video could be found at the QR code.

TOOLS AND METHODS

The sonification and visualization tools for photometric and spectroscopic astronomical data, make inclusion possible using a novel multimodal approach, but in this case presented through a Jupyter notebook.

- Chemical composition
- Detection of pics.
- Spectra comparison.
- Light curves analysis
- Comparison of data
- Detection of absorption

CONCLUSION

SonoUno libraries could be used on a Jupiter Notebook to generate the plot and sonification of datasets. For this technique to be widely implemented, the scientific community must contribute to its validation and use in scientific discoveries through posters, oral contributions, proceedings, or papers.

CONTACT US

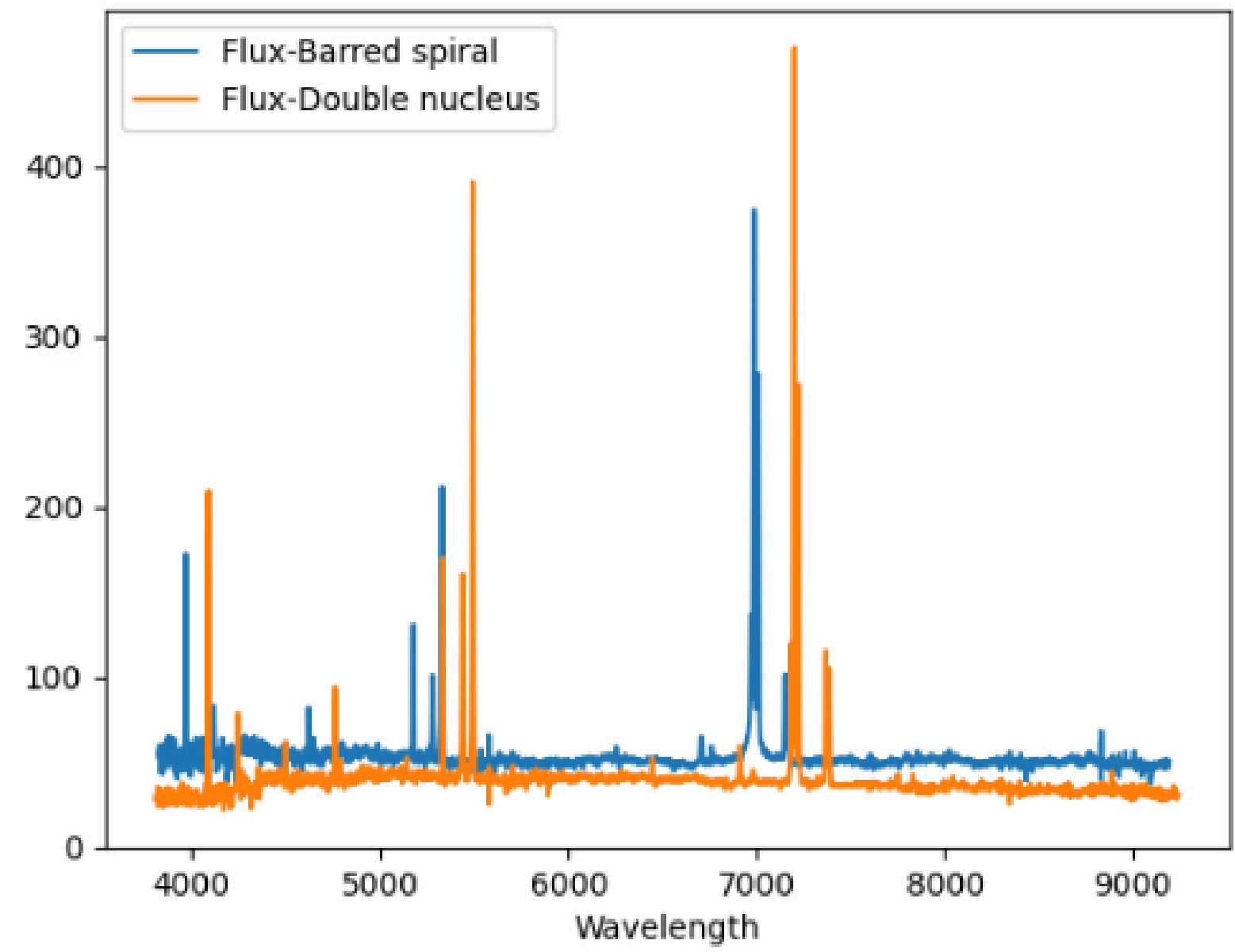
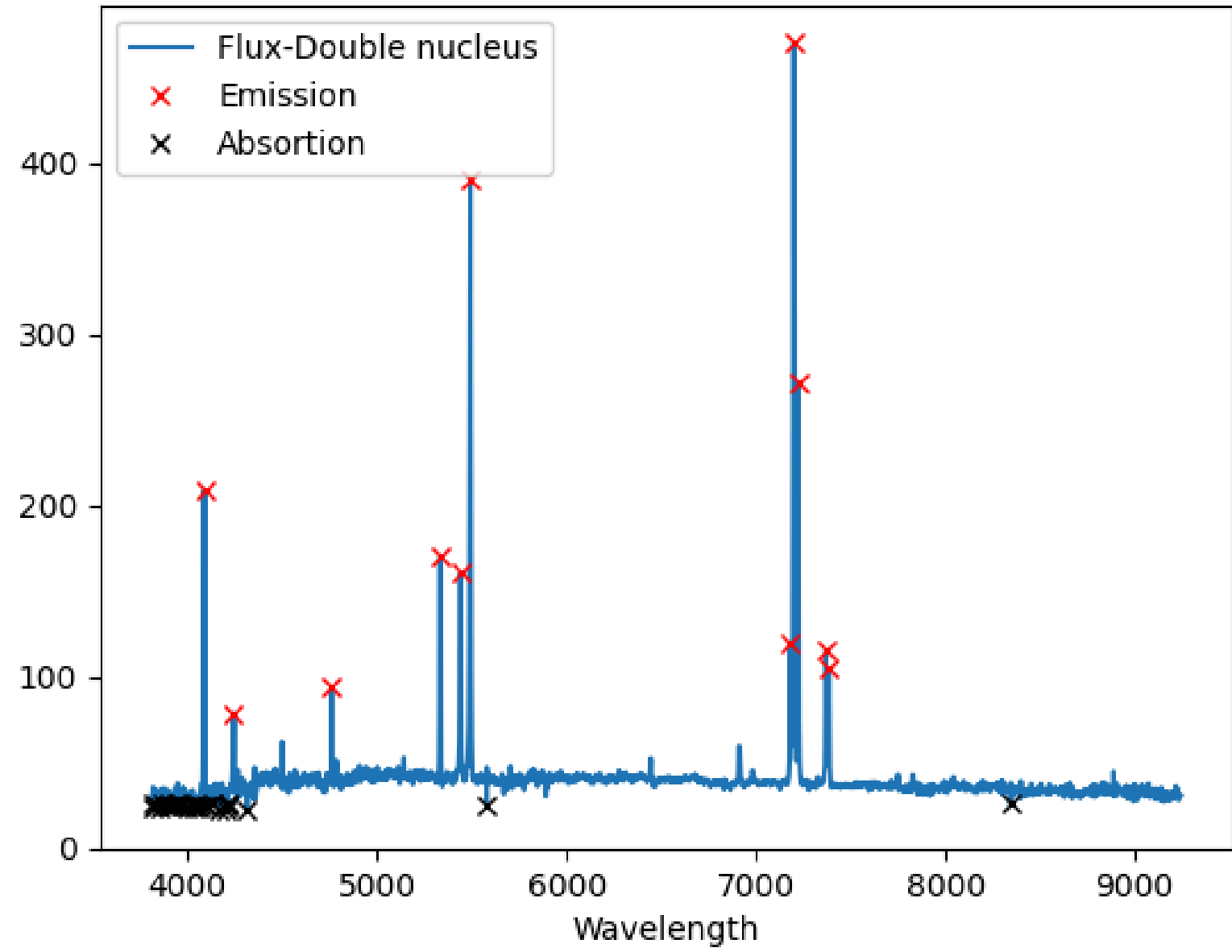
sonounoteam@gmail.com
www.sonouno.org.ar

The original data links could be found at the QR code



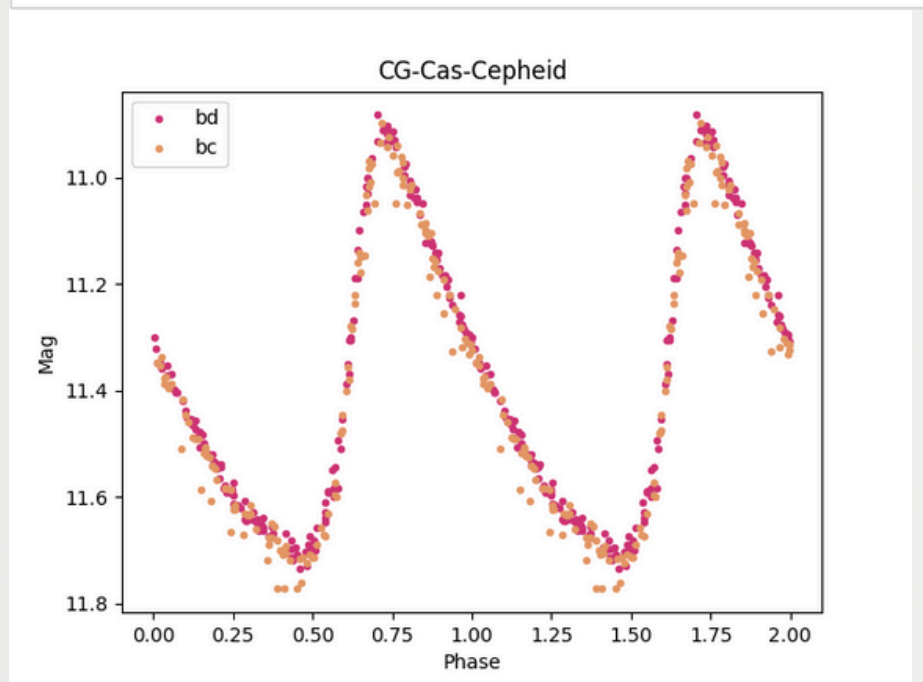
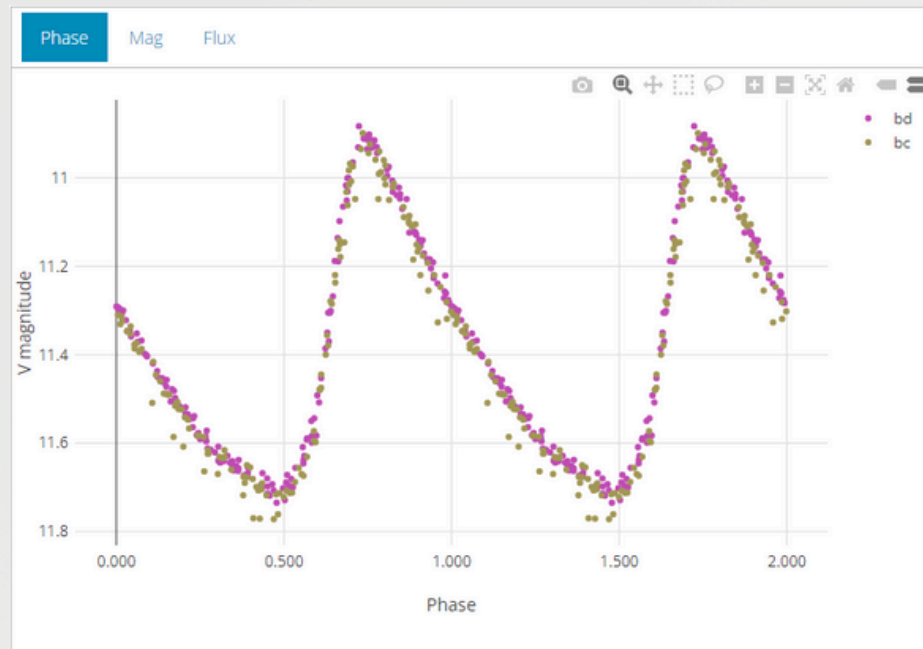
Galaxy spectra (peaks and comparison)

SDSS J170437.70+603506.4

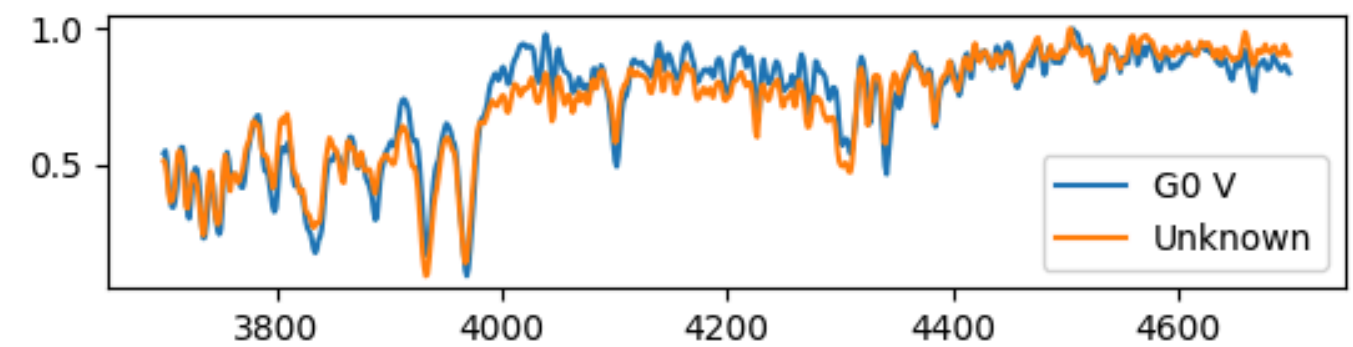
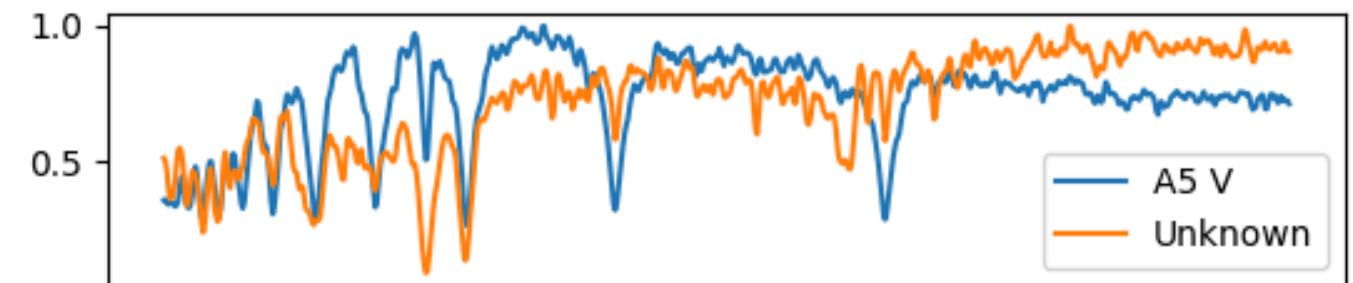
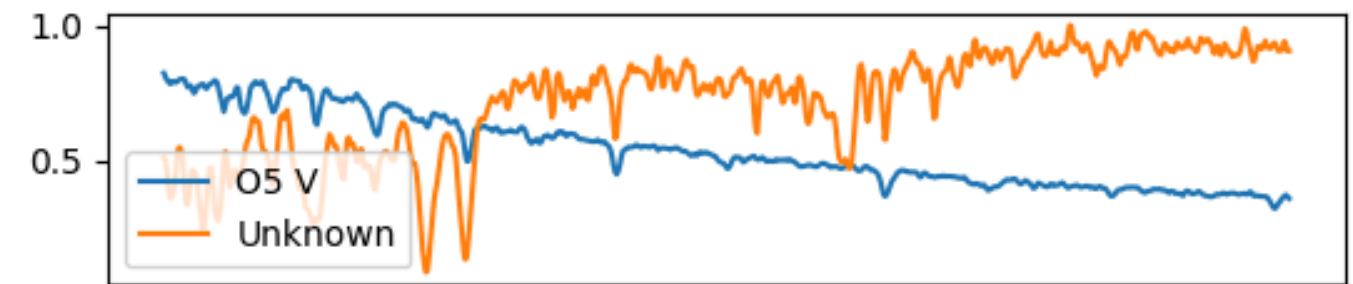




Light curves (Phase diagram)



Star classification



SonoUno
links



Important links



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

