Carolina Cenzano

Title

Exploring overdensities in the Milky Way halo using machine learning and RR Lyrae stars

Abstract

The currently hierarchical model of the formation of the Milky Way is based on the idea that a series of accretion and merging events led to its assemble. These accretion events may leave their imprint in the form of structures such as stellar streams, shells or clouds, which appear as overdensities with respect to the underlying halo distribution. Thus, finding new overdensities idates is crucial to properly infer our galaxy's formation history.

RR Lyrae (RRL) stars have been used to find or trace the shapes of many Milky Way halo overdensities. This is because RRL are sufficiently rare to not randomly form in pairs outside of stellar structures. However, we required a kinematic analysis on RRL to relate them to the same structure.

In our work, we had been analyzing the orbits and special distribution of known overdensities and new idates. Our sample of RRL contains their 3D spatially positions, proper motions, radial velocities, and in some cases chemical composition.

In this talk, we will be sharing our kinematic analysis of this sample. We will also discuss the importance of finding new overdensities and how increasingly larger databases, such as afforded by Gaia, make it necessary to implement improved data analysis techniques in order to more proper and efficient analysis.

Finally, we will discuss the efficiency of clustering algorithms, such as DBSCAN, in the

classification of new idates of stellar overdensities, by analyzing the effectiveness to recognize known overdensities, such as Virgo Overdensity.

Carolina Maritza Cenzano Silva

Personal Information

RUT:	19.307.402-2
Nationality:	Chilean
Date of Birth:	March 8, 1996 (25 years old)
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Education

2020-	PhD. student in Astrophysics, Pontificia Universidad Católica de Chile Working with traditional techniques that have been used to detect and characterize overdensities and streams. Developing new algorithms based on density-based clustering algorithms.
2015-2019	BSc. Astronomy, Pontificia Universidad Católica de Chile Thesis: "Substructure in the Milky Way Halo as Traced by RR Lyrae Stars" Advisor: Prof. Márcio Catelan **PGA: 5.94/7.0**

Publications

2021	Rodríguez-Segovia N., Hajdu G., Catelan M., Espinoza-Arancibia F., Boggiano G., **Cenzano C.**, Garcés H E, 2021, MNRAS, Advance Access. "Period change rates in large magellanic cloud cepheids revisited" doi:10.1093/mnras/stab3246
2021	Piatti A. E., Mestre M. F., Carballo-Bello J. A., Carpintero D. D., Navarrete C., Mora M. D., **Cenzano C.**, 2021, A&A, 646, A176 "Signatures of tidal disruption in the Milky Way globular cluster NGC 6981 (M72)" doi:10.1051/0004-6361/202040038
2020	Piatti A. E., Carballo-Bello J. A., Mora M. D., **Cenzano C.**, Navarrete C., Catelan M., 2020, A&A, 643, A15. "The elusive tidal tails of the Milky Way globular cluster NGC 7099" doi:10.1093/mnras/stab3238

Research Experience

Research Interests	Variable Stars Stellar Evolution Streams and Overdensities Formation and Evolution of the Milky Way Globular Clusters and Local Group Galaxies Big Data Bases Analysis and development of Computational tools for Statistical Studies
August-December 2021	Photometry and Proper Motions of the Milky Way Bulge, PUC Advisor: Manuela Zoccali Do the photometry process from DECAM observations in the Milky Way Bulge. Deriving their proper motions from old measuments
August-December 2020	Chilean ESO Intership, PUC Advisor: Camila Navarrete Studying RR Lyrae both from old and new overdensities detected in the Milky Way halo (in particular, with the recently discovered Gaia-Enceladus and Gaia-Sequoia overdensities). Then apply techniques of clustering to search for new possible groups using the 6D information. Finally derivate of orbits and main dynamic parameters to characterize the population of RR Lyrae stars (both, as part of halo overdensities as well as RR Lyrae stars from the "smooth" halo).
September-December 2019	Thesis BSc. Student, PUC *Substructure in the Milky Way Halo as Traced by RR Lyrae Stars* Advisor: Márcio Catelán The detection of overdensities and streams in the Milky Way halo can help shed light on our galaxy's early history, thus also helping constrain hierarchical models for the formation of large galaxies more generally. The attempt is to continue the investigation Torrealba et al. (2015), who identify a series of overdensities candidates in the southern galactic Halo, using RR Lyrae data from the Catalina Sky Surveys. This time, his investigation is extended by incorporating RR Lyrae data from the Gaia Data Release 2, along with other datasets from the literature.
August 2019	Group Project of Machine Learning, AURA Chile *Gamma Ray reconstruction using Machine Learning* Advisor: Mauricio Araya Construction of neural networks using Supervised Machine Learning, in other to reconstruct the information of energy and position of Gamma Rays. It was used as training data simulations of The Cherenkov Telescope Array (CTA)
January-July 2019	Research Assistant, PUC *Crossmatch of Surveys* Advisor: Márcio Catelán List the number of RR Lyrae's candidates from Gaia DR2 that were already found and present in other catalogues, and finding incoherences (different classifications of a same star)
April-May 2019	Research Assistant, PUC *Variable stars in Omega Cen* Advisors: Camila Navarrete and Márcio Catelán Finding new Variable Stars in Omega Cen, mostly detected by Gaia DR2 and analysed the fidelity of the automatic classifications of Gaia DR2
Julio 2018	Winter Investigation Project (VRI), PUC *Search for variable stars in the galactic bulge (M22)* Advisors: Manuela Zoccali y Rodrigo Contreras Study of 1086 Light curves from the project VVV (Vista Variables of the Via Láctea). They were classified by variability type, considering amplitude, period and shape of the light curve. Then, their proper motions were studied to determine whether or not they belong to the M22 cluster

Observing Experience

2 Nights	4-m Blanco Telescope: DECam, CTIO. Project: "The outer structure and the in-situ/extra-Galactic origin of globular clusters" IP: J. Carbalo-Bello (PUC)

Computer Skills

Basic Knowledge	Gaussian Regression, Text Analysis,
	SExtractor, CASA, High Performance Computing
Intermediate Knowledge	Python, ADQL, SQL, Clustering Algorithms, TOPCAT, Linux, IRAF, LaTeX, Image Analysis, Large Databases

Workshops and Conferences Attendance

December 2020	Sochias Anual Metting 2020 (Sochias: Chilean Astronomy Society): Tittle: "Machine Learning Techniques for Stream Detection in the Milky Way Halo".
November 2019	Poster at Latin American Regional IAU Meeting (LARIM) 2019 Antofagasta: Tittle: "Searching new overdensities with RR Lyrae from Gaia Data Release 2".
August 2019	La Serena School of Data Science - AURA Chile
March 2019	ALMA Community Day in Santiago 2019 - ESO Chile
December 2018	Near-Field Cosmology in the Era of Large Surveys Workshop - Astrofísica UC

Teaching experience

2018-2020	*Teacher's Assistant in the Institute of Astrophysics and in the Physics Faculty of the Pontificia Universidad Católica de Chile* 2018: Ondas y Óptica - Felipe Veloso 2019: Astronomía - Manuela Zoccali 2019: Astronomía - Viviana Guzmán 2020: Astronomía - Álvaro Rojas
2017-2018	Teaching - Private Teacher Class Planning as a Private Physics teacher for High School students

Science Outreach and Trainings

December 2021	Astro Con Fundación Astromanía Convention of all class of astronomy related subjects. Selling of art and objects related to the cosmos and answer questions about astronomy and the astronomy career to the public.
November 2020	Online Outreach Talk: "Studying the Milky Way Halo using variable stars" Physics and Astronomy Student Center An online talk about my work in Astronomy, focus to all public (not astronomers)
October 2019	Activity "Conversa con una Astrónoma" (Talk with Woman Astronomer) Penta UC Talk to schoolchildren, who are studying seventh or eighth grade, about the work of an astronomer and female representation in the field
March 2019	Inclusive Astronomy Training - Dedoscopio A training activity to learn how to teach astronomy to visually impaired people
August 2018	Optative Training Leassons for Teaching's Assistant/Ayudantes UC - UC
Octubre 2018	Expo Futuro Novato UC, PUC An activity for high schoolers to talk them about the astronomy undergraduate program in the Pontificia Universidad Católica de Chile

Future Projects

January 2022	Sochias Anual Metting 2022 (Sochias: Chilean Astronomy Society): Tittle: "Clustering Algorithms for finding Overdensities Candidates".

Languages

Spanish:	Mother Tongue
English:	Fluent

Extra-curricular Activities

2021-

Volunteer in Plastic Ocean NOG

Volunteer in Plastic Ocean, an environmental nonprofit organization whose goals is to clean and reduce the plastic in the ocean and beaches across the country.

2020-

Volunteer in Ingeniosas NOG

Volunteer in Ingeniosas, an educational nonprofit organization whose goals is to incentivize girls for STEM careers.

2020-

Lookin Up Studios art page

I am also a self taught watercolor and digital artist that sells my art pieces via instagram and art fairs. I also do tutorials to teach people how to paint digital and watercolor paintings

Other hobbies and goals

I enjoy trekking and camping. I been in multiple natural parks and reserves in my country. My dream is to have my own self-sustaining house

References

1. Márcio Catelan
   Full Director of the Undergraduate Program and Full Profesor
   The Institute of Astrophysics of the Pontificia Universidad Católica de Chile (UC)
   Av. Vicuña Mackenna 4860, 782-0436
   Macul, Santiago, Chile.
   marcatelan@gmail.com
   Relationship: PHD and BSc. Thesis Advisor
2. Kathy Vivas
   Associate Astronomer CTIO
   Cerro Tololo Inter-American Observatory
   AURA Observatory in Chile
   Colina El Pino S/N -or- Juan Cisternas 1600
   La Serena, Chile
   kvivas@ctio.noao.edu
   Relationship: BSc. Co-Thesis Advisor
3. Camila Navarrete: ESO Fellow with duties in Paranal in Chile
   European Organisation for Astronomical Research in the Southern Hemisphere.
   Alonso de Córdova 3107
   Vitacura, Santiago, Chile
   cnavarre@astro.puc.cl
   Relationship: Served as a research collaborator during BSc and PHD Thesis
4. Julio Carballo Bello: Independent Researcher
   Instituto de Alta Investigación - Universidad de Tarapacá
   José Victorino Lastarria 26, Santiago, Región Metropolitana
   Aníbal Pinto 595, Iquique, Tarapacá
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   Relationship: Served as a research collaborator during BSc and PHD Thesis