Louise Breuval

Title

Calibrating the Cepheid distance scale with Gaia

Abstract

Cepheid stars play a considerable role as astronomical distances indicators thanks to the empirical relation between their pulsation period and intrinsic luminosity: the PL relation. The uncertainty on this relation is the largest contributor to the error budget of the Hubble constant, that describes the Universe's expansion. The value of the Hubble constant is currently at the center of a major controversy: while it is estimated at 67.4 +/- 0.5 km/s/Mpc by the Planck satellite, the local measurement based on Cepheids is larger by 4 sigma, with a value of 74.0 +/- 1.4 km/s/Mpc. This discrepancy may provide evidence for physics beyond the standard model: it is therefore critical to improve the PL calibration with precise and accurate distance measurements of Cepheids.

In 2018, the second data release of the Gaia satellite (Gaia DR2) provided parallaxes for 1.3 billion stars with an unprecedented precision. However, Cepheids are bright stars and are often saturated in detectors. Moreover, the variations in brightness and color that occurs for variable stars like Cepheids are not yet taken into account in the Gaia data reduction. Therefore, Cepheids parallaxes can be affected by systematics due to their photometric variability.

In order to avoid these issues, a solution is to find stable and faint companion stars in the close environment of Cepheids. Using 36 indirect, unbiased and accurate distances based on Gaia DR2, I calibrate the PL relation and revise a previous value of the Hubble constant based on HST measurements of Galactic Cepheids.

Louise Breuval

Observatoire de Paris, LESIA, 5 Place Jules Janssen, 92195 Meudon, FRANCE
louise.breuval@obspm.fr

—— Profile

2018-2021 **PhD at Paris Observatory - LESIA**, France. Advisor: Dr Pierre Kervella
"*The Cepheid distance ladder: from the local Gaia calibration to distant galaxies*"
(PhD defense planned on October 2021)

—— Education

2016-2018 **Master in Astronomy & Astrophysics,** Paris Observatory / Paris Saclay University
2015-2016 **Bachelor in Fundamental Physics,** Paris Saclay University

—— Experience

2020 Observations (~50 nights) at Cerro Armazones Observatory (OCA), Chile.
IR photometry of variable stars with telescopes of 80 cm, 40 cm and 25 cm.

2018 Master internship (3 months) at Instituto de Astrofísica de Canarias, Tenerife, Spain. "*Influence of quasar outflows on the galaxies young stellar populations*"
Observations (2 nights) with GTC/EMIR, Roque de los Muchachos Observatory.

2017 Master internship (3 months) at Observatorio Astronómico Nacional, Santiago, Chile. "*Interferometric study of Pulsating Stars with VLTI-PIONIER*".
Observations (2 nights) with VLTI-PIONIER, Paranal Observatory, ESO.

—— Publications in refereed journals

- ***The Milky Way Cepheid Leavitt law based on Gaia DR2 parallaxes of companion stars and host open cluster populations***. Breuval L., Kervella P., Anderson, R. I., Riess, A. G. et al., A&A, 643, A115 (2020)
- ***Pulsating chromosphere of classical Cepheids. Calcium infrared triplet and Hα profile variations***. Hocdé V., Nardetto N., ..., Breuval L. et al., A&A, 641, A74 (2020)
- ***A thin shell of ionized gas as the explanation of infrared excess among classical Cepheids***. Hocdé V., Nardetto N., ..., Breuval L. et al., A&A, 633, A47 (2020)
- ***Testing systematics of Gaia DR2 parallaxes with empirical surface brightness: color relations applied to eclipsing binaries***. Graczyck D., Pietrzyński G., ..., Breuval L., ApJ, 872, 85 (2019)
- ***Consistent radial velocities of classical Cepheids from the cross-correlation technique***. Borgniet S., Kervella P., ..., Breuval L. et al., A&A, 613, A37 (2019)

—— Talks and presentation of scientific results

- Gaia EDR3 Day, Presentation of Gaia DR2 scientific results, 3 December 2020, Paris, France
- Seminar at the Laboratory for Nuclear and High Energy Physics, 28 September 2020, Paris, France
- MW-Gaia WG2/WG3 Workshop (invited), 21-23 January 2020, Zagreb, Croatia
- Dark Energy Colloquium (invited), 20 November 2019, Institut Henri Poincaré, Paris, France
- RRL/Cep - Frontiers of Classical Pulsators, 13-18 October 2019, Cloudcroft, NM, USA
- Cosmic Controversies Conference, 5-8 October 2019, Chicago, IL, USA
- Annual Meeting of the French Society for Astronomy and Astrophysics, 14-17 May 2019, Nice, France
- Araucaria Project Group Meeting, 5-8 March 2019, Concepción, Chile

—— Teaching

2021	Supervision of a Master Student (50h/yr)
2019-2021	Optics - 1st year of Physics Degree, Paris Sciences et Lettres University (36h/yr)
2019-2021	Introduction to astronomy - 1st year of University, Paris Observatory (20h/yr)
2019-2021	Educational projects with school teachers (∼4/yr)

—— Awards and other activities

2020	Member of the french association *Femmes et Sciences*, that promotes science to young women
2019	Prize of the best poster presentation at the *Cosmic Controversies Conference* in Chicago
2019 - ...	Elected as Student Representant at the Executive Board of Paris Observatory
2018 - ...	Member of the Araucaria Project, a team of astronomers from France, Poland and Chile, that aims at improving the calibration of the cosmic distance scale in the local Universe

—— Computer skills

Python, C++, IDL
MacOS, Linux, Windows

—— Languages

French (native)
English (fluent)
Spanish (fluent)
German (intermediate)