Emma Bordier

Title

The formation of massive close binaries: is the migration scenario viable?

Abstract

The formation of high-mass stars has seen some significant progress over the past years. Still, being deeply embedded in their natal envelope, a definitive observational sequence for their formation is yet to be obtained.
Most main sequence massive stars (~70%) belong to short-period binaries, a fact that does not reflect the binary parameters measured among populations of newly born massive stars. To bridge the gap between these two regimes, we need to obtain strong constrains on the origin of the pairing mechanism and the birth orbital properties. Different scenarios have been proposed to produce close binaries, such as the migration, in which massive binaries are originally formed at large separations and then harden on a time-scale of ~2 Myr. A strong test for this scenario is the presence of a significant number of relatively massive companions at separations corresponding to the expected size of the accretion disk. Being one of the youngest cluster in our Galaxy, M17 is an unprecedented laboratory where (proto)binaries can be caught during or immediately after their formation phase. In my talk, I will describe how optical interferometry (GRAVITY) and high-angular resolution techniques (NACO) are of great importance in characterizing multiplicity at birth. From the interferometric model fitting of visibility amplitudes and closure phases, I will present some of my latest exciting results, including two important concepts: the multiplicity and companion fraction. These results will be compared to other recent studies. Finally, I will discuss the connection with the current star formation theories and how the advent of future VLTI instrumentation will bring another piece to the puzzle.

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PhD Student

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Currently enrolled in a PhD at KU Leuven and ESO. Especially motivated by observational astronomy and passionate about stellar physics. Previous works and research have mainly focused on evolved stars using mid-IR to sub-mm spectroscopic data. Now interested in the origin of massive binaries in order to figure out the processes leading to the pairing mechanism. As such, I mainly make use of interferometric (VLTI/GRAVITY) and high-angular resolution imaging (VLT/NACO) data.

Education

Now -2023 — PhD Student in Astrophysics, Instituut voor Sterrenkunde (IvS), KU Leuven and ESO, Santiago, Chile
- *Title : 'The origin of Massive Close Binaries', under supervision of :* Prof. Hugues SANA *and* Dr. Willem-Jan DE WIT.

September 2017 July 2019 — Master's Degree in Fundamental Physics & Astrophysics, Universite Paris-XI, Paris-Saclay
- Master 2nd year in Astronomy, Astrophysics & Ingenierie Spatiale (Cum Laude), *Observatoire de Paris-Meudon*
- *Master 1st year in Fundamental Physics, Universite Paris XI, ParisSaclay*
- *2nd and 3rd years of 'Magistere' Program in Fundamental Physics (Cum Laude), Universite Paris XI, ParisSaclay*

September 2014 July 2017 — Bachelor in Fundamental Physics, Universite Paris-XI, Paris Saclay
- Bachelor 3rd year in Fundamental Physics, *Universite Paris XI, Paris-Saclay*
- *1st and 2nd years : Classes Preparatoires aux Grandes Ecoles (CPGE), Maths & Physics, Lycee Joffre, Montpellier*

Work Experience

April-August 2019 — **16-week internship, Canada France Hawaii Telescope (CFHT)**, Waimea, Hawaii.
Characterization of unknown circumstellar envelopes using far-IR and sub-mm Herschel data, under supervision of : **Dr. Nicolas FLAGEY**.

April-August 2018 — **17-week internship, Academia Sinica Institute of Astronomy and Astrophysics (ASIAA)**, Taipei, Taiwan.
Mid-infrared spectroscopic classification of Nearby Evolved Stars Survey targets, supervised by : **Dr. Francisca KEMPER**.

June-July 2017 — **6-week internship, Laboratoire de l'Atmosphere et des Cyclones (LACy)**, Saint-Denis, Ile de la Reunion.
Exploitation of weather variables from COSMIC GPS data above French Guyana for estimating solar energy, under supervision of : **Dr. Fabrice CHANE MING**.

Observing experience and projects

February 2020 — **Mercator Telescope at Observatorio del Roque de los Muchachos**, La Palma, Canarias.
Observing run of 10 nights as part of my observing duties at IvS (KU Leuven).

April-August 2019 — **Canada France Hawaii Telescope (CFHT)**, Waimea, Hawaii.
Remote observing sessions on SPIRou and MegaCam with the on-site observers.

March 2019 — **1-week observation run and data analysis, Observatoire de Radioastronomie de Nancay, Nancay, France**.
Measuring galactic HI lines using the NRT (Nancay Radio Telescope).

Jan.-March 2019 — **6-week project, Institut d'Astrophysique Spatiale (IAS), Orsay, France**.
Planck Image Processing : highlight the SZ signal using stacking and statistic methods.

January 2019 — **1-week observation run and data analysis, Observatoire de Haute-Provence (OHP)**, Saint-Michel-l'Observatoire, France.
Deep-fields and galaxies statistics using the 1.2m telescope.

Sept.-Nov. 2018 — **6-week project : observations and data analysis, Observatoire de Meudon**, Paris-Meudon, France.
Stellar spectroscopy using 60cm telescope at Table Equatoriale *and targeting different spectral-type stars.*

The different projects were done in Python using some packages and modules like SExtractor, Scamp and SWarp. For each of these projects conducted in groups of 2 or alone, an oral presentation was requested together with a report written in LaTeX.

Grants and Scholarships

January 2020	ESO, Chile : Studentship awarded by ESO with a contract of 2 years to pursue my PhD at ESO, Vitacura.
April 2019	Paris-Saclay : International scholarship awarded by Universite Paris-Saclay as part of my internship at the Canada France Hawaii Telescope, Hawaii.
June 2018	Ministery of Science and Technology of Taiwan (MOST), Summer 2018 : Studentship awarded as part of the end-of-year internship at ASIAA.
July 2018	ASIAA Summer Student Program : Grant awarded as part of the end-of-year internship at ASIAA within Dr. Francisca Kemper's team.

Succesful proposals

2020	**VLTI/GRAVITY : Testing the migration scenario in M17 for the formation of close massive binaries. ID : 109.239M. PI : E. Bordier**
2020	VLTI/PIONIER and GRAVITY : Constraining the cosmic dance of massive stars in triple systems. ID : 109.23HT. PI : H. Sana

Contribution to Education and Outreach

2022	March 19th : Astronomy Day in Chile. Outreach sessions in the Bicentenario Park.
2021-2022	Letters to a Pre-Scientist : 1 year of mail exchanges with a paired student in US low-income communities.
2021	*How do we form stars and planets ?* and *Becoming an Astronomer*. Several talks at secondary schools in *La Réunion (home island)*.
2019-2020	Co-supervision of a Bachelor Project : *Detection and characterization of massive stars binaries by fitting optical interferometry data (CHARA data)*.

Community Service

2022	LOC member of the conference *Joint Observatories Kavli Science Forum in Chile.*
2021-2022	Co-organizer of the ESO Friday Lecture Series.
2021-2022	Organizer of the weekly ESO Wine & Cheese.
2021	Scientific Assistant of the Observing Programmes Committe (OPC) Panel Meetings for P108 and P109.

General Skills

Computer	MacOs, Python, C, C++, LaTeX, ds9, JMMC packages, OIUTILS and PMOIRED, Microsoft Office
Languages	French (native), Reunionese Creole (Native), English (professional proficiency), Spanish (elementary)