NICOLA GIACOBBO - CURRICULUM VITAE

CONTACT DETAILS

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EDUCATION

10/2016 - now: Ph.D student in Astronomy, University of Padova, Italy. Thesis on "*Demography of compact object binaries in the epoch of multi-messenger astronomy*", Supervisor: Dr. Michela Mapelli.

10/2017 - 12/2017: Visiting Ph.D student in Astronomy at Universiteit Leiden, hosted by Prof. Dr. Simon Portegies Zwart. I learnt how to use the software framework called AMUSE. I also worked to integrate in AMUSE our codes (SEVN and MOBSE).

09/2014 - 09/2016: Graduate student, University of Padova. Master Thesis on *"A new population-synthesis code for the study of the demography of black hole binaries"*, supervisor: Prof. Paola Marigo, co-supervisors: Dr. Michela Mapelli, Dr. Mario Spera. Master in Astronomy obtained on September 28^{th} 2016, mark 110/110 cum laude.

09/2009 - 03/2014: Undergraduate student, University of Padova. Thesis on *"Bayesian analysis of stellar clusters using a Monte Carlo Markov Chain algorithm"*, supervisor: Prof. Paola Marigo. Bachelor in Astronomy obtained on March 12^{th} 2014, mark 97/110.

FELLOWSHIPS & GRANTS

07/2017 - now: CO-I of proposal "The impact of stellar dynamics on gravitational-wave source". Awarded 6,000,000 CPU+GPU hours on the CINECA supercomputers MARCONI-A2 and GALILEO.

03/2018 - 09/2018 Grant (5k EUR for 6 months) awarded by Fondazione Ing. Aldo Gini.

03/2013 - 06/2013: Erasmus student at Leibniz Institute for Astrophysics Potsdam (AIP). I obtained an Erasmus Placement scholarship on February 2013.

09/2011 - 03/2012: Erasmus student at Ruprecht Karl University of Heidelberg. I obtained an Erasmus Studium scholarship in April 2011.

PUBLICATIONS

2018: **N. Giacobbo**, M. Mapelli and M. Spera, "Merging black hole binaries: the effects of progenitor's metallicity, mass-loss rate and Eddington factor", 2018, MNRAS, 474, 2959.

2017: M. Mapelli, **N. Giacobbo**, E. Ripamonti, M. Spera, "The cosmic merger rate of stellar black hole binaries from the Illustris simulation", 2017, MNRAS, 472, 2422.

2016: M. Spera, **N. Giacobbo**, and M. Mapelli, "Shedding light on the black hole mass spectrum", accepted for publication in "Memorie della SAIt" (proceeding of the MODEST 16 conference, April 18–22 2016, Bologna).

COLLOQUIA, TALKS AND SCHOOLS

11/2017: Participant at the kick-off meeting of "*The evolution of Rich Stellar Population & Black Hole Binaries*" (`http://www.issibern.ch/teams/blackholebinary/`) sponsored by ISSI in Bern, Switzerland.

05/2017: Participant at the "*26th Summer School on Parallel Computing*" organized by CINECA in Bologna, Italy.

05/2017: Participant at the "*INFN School of Statistics 2017*" provide by INFN and organized in Ischia, Italy.

02/2017: Participant at the course "*Introduction to Parallel Computing with MPI and OpenMP*" at CINECA, Bologna, Italy.

11/2016: Workshop on "*Synergy between Population-synthesis models and LIGO-Virgo data analysis*", INFN Padova, Italy, oral presentation.

IT KNOWLEDGE

Operating Systems: GNU/Linux (excellent), Mac OS (excellent) and Windows.

Programming languages: C++, Fortran 77 and 90, PYTHON, MATLAB, LaTeX.

Codes, user: BSE (population synthesis code, `http://astronomy.swin.edu.au/~jhurley/`).
AMUSE (Astrophysical Multipurpose Software Environment, `http://www.amusecode.org`).

Codes, developer: Stellar-EVolution for N-body (SEVN) code (Spera et al. 2015, MNRAS, 451, 4086), see section *scientific interests* for more details about the codes I have developed.
Massive Objects in BSE (MOBSE) population synthesis code (Giacobbo in preparation).

Experience in parallel computing: Usage of OpenMP and MPI.

SCIENTIFIC INTERESTS

Ph.D Project: The recent direct detection of gravitational waves (GWs) by advanced LIGO confirmed the existence of double black hole (BH) binaries, which can merge within a Hubble time. Moreover, three of the fifth detected events (GW150914, GW170104 and GW170814) demonstrated the existence of heavy BHs, with mass > 30 $M_{\odot}$. Despite the importance of stellar-born compact objects for a plethora of astrophysical processes (i.e. X-ray binary, GW emission, etc), their mass spectrum is still matter of debate. Furthermore, the evolutionary channels of merging BHBs are still an open question. The main topic of my research (started during my master thesis) consists in studying the demography of double-compact object binaries by developing new population-syntheis tools and by coupling them with direct N-body simulations. My aim is to break current degeneracies between the two possible evolutionary channels of compact object binaries: primordial and dynamically formed binaries. This will allow me to put constraints on the origin of detected LIGO events and to make predictions for future observations.

M. Sc. Thesis abstract: The aim of my Master Thesis was to study the demographics of merging black hole (BH) binaries, by means of a new population-synthesis tool. I used SEVN (Stellar EVolution for N-body), a new public population-synthesis code developed by Spera, Mapelli & Bressan (2015, MNRAS, 451, 4086) where I implemented the module for the common-envelope (CE) evolution. I started working on the CE phase because it is one of the most important processes to explain the formation of close compact-object binaries. I tested the new CE module in SEVN. For the second part of my Thesis, I did two important upgrades to BSE (Hurley et. al 2002, MNRAS, 329, 897). I added a new model of stellar winds (Vink et al. 2001a, A& A, 369, 574) and new recipes for two supernova explosion mechanisms called rapid and delayed (SNe, Fryer et al. 2012, ApJ, 749, 91). Finally, I have been running a grid of binary evolution models, to study the demographics of BH and neutron star (NS) binaries. My results show that the physics of stellar winds is crucial to explain the formation of massive BH binaries.

B. Sc. Thesis abstract: The aim of my Bachelor Thesis was the characterization of two open clusters, NGC 6811 and NGC 6819, by using a code developed during an internship at AIP (Leibniz Institute for Astrophysics Potsdam). Given in input a set of theoretical isochrones and photometric data of a cluster, the code uses an iterative method, based on the Monte Carlo Markov Chain algorithm, to determine the best-fitting parameters of the cluster (age, metallicity, distance, and reddening). The same method has been applied to NGC 6811 for the first time by Janes et. al (2013, AJ, 145, 7) and we used this article as a reference for our work. Firstly, I have tested the code on the already characterized cluster NGC 6811, using as input two different grids of isochrones (from Padova-Trieste PARSEC version 1.1 and Yale-Yonsei YY group) and photometric data in different filters available at KIC (Kepler Input Catalog). I obtained a good match with Janes et al. (2013), and then I applied this method, for the first time, to the cluster NGC 6819. The results I obtained are in agreement with the literature.

Celestial Mechanics: During my Master courses, I have developed a Matlab®code for a project of the Celestial Mechanics class (lecturer: Dr. Stefano Casotto). The goal of this project was to compare two different analytical methods in order to study the perturbations of the six orbital elements of a satellite moving around the Earth. I took into account only the effect of the gravitational field of an oblate Earth in absence of air-drag. In addition, I did the assumption that the gravitational field is axially symmetric, with respect to the rotation axis, so it can be expanded into a series of spherical harmonics. The two analytical methods considered in the project were developed by Kozai (1959, AJ, 64, 367) and Liu (1974, AIAAJ, 12, 1511) respectively, and they have been compared with the numerical solution (Cowell's method) assumed to be the true solution. My results show beyond a shadow of doubt that the method developed by Liu is the most accurate one.

ACCADEMIC REFERENCES

Prof. Michela Mapelli INAF - Astronomical Observatory of Padova, Vicolo dell'Osservatorio 5, I-35122 Padova, Italy
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