Hunting for the fastest stars in the Milky Way

Marchetti, T.

List of Publications

First author

Marchetti, T.; Rossi, E. M.; Brown, A. G. A.; *Gaia DR2 in 6D: Searching for the fastest stars in the Galaxy*, 2018, MNRAS.

Marchetti, T.; Contigiani, O.; Rossi, E. M.; Albert, J. G.; Brown, A. G. A.; Sesana, A.; *Predicting the hypervelocity star population in Gaia*, 2018, MNRAS, 476, 4697-4712.

Marchetti, T.; Rossi, E. M.; Kordopatis, G.; Brown, A. G. A.; Rimoldi, A.; Starkenburg, E.; Youakim, K.; Ashley, R.; *An artificial neural network to discover hypervelocity stars: candidates in Gaia DR1/TGAS*, 2017, MNRAS, 470, 1388-1403.

Contributing author

Contigiani, O.; Rossi, E. M.; **Marchetti, T.**; *On measuring the Galactic dark matter halo with hypervelocity stars*, 2019, MNRAS.

Rossi, E. M.; **Marchetti, T.**; Cacciato, M.; Kuiack, M.; Sari, R.; *Joint constraints on the Galactic dark matter halo and Galactic Centre from hypervelocity stars*, 2017, MNRAS, 467, 1844-1856.

Coppi, G.; **Marchetti, T.**; de Bernardis, P.; Masi, S.; *Measurements of the polarization properties of foam materials useful for mm-wave polarimeters windows*, 2016, JIMTW, 37, 8, 815-824.

Conference proceedings

Marchetti, T.; Rossi, E. M.; Kordopatis, G.; Brown, A. G. A.; Rimoldi, A.; Starkenburg, E.; Youakim, K.; Ashley, R.; *Hypervelocity star candidates in Gaia DR1/TGAS*, 2018, Astrometry and Astrophysics in the Gaia sky, Proceedings of the International Astronomical Union, IAU Symposium, Volume 330, pp. 181-184.

Legg, S.; Lamagna, L.; Coppi, G.; de Bernardis, P.; Giuliani, G. M.; Gualtieri, R.; **Marchetti, T.**; Masi, S.; Pisano, G.; Maffei, B.; *Development of the multi-mode horn-lens configuration for the LSPE-SWIPE B-mode experiment*, 2016, proceedings of the SPIE.

Lamagna, L.; Coppi, G.; de Bernardis, P.; Giuliani, G. M.; Gualtieri, R.; Legg, S.; Maffei, B.; **Marchetti, T.**; Masi, S.; Pisano, G.; *Development of the multi-moded pixels for the LSPE/SWIPE focal plane*, 2015, proceedings for the 36th Antenna Workshop on Antennas and RF Systems for Space Science.

Curriculum Vitae

I was born on the 26th of December 1991 in Rome, Italy. I would be lying if I said that I have always been fascinated by astronomy. As a kid, my true passion was dinosaurs, and my dream was to become a paleontologist. Moving from elementary to middle school I started being more and more attracted to scientific subjects, with a particular interest in maths. This led me to take the decision to enroll in a scientific high school, the Liceo Scientifico "Isaac Newton" in the centre of Rome. This school was part of a project called PNI (literally national plan for computer technology, *Piano Nazionale Informatica* in Italian), a special program with mandatory classes of physics for all the 5 years. Nevertheless, for a few years, I seriously considered the idea of enrolling in history at university, to become an archaeologist. It was only in the fourth year of high school that I decided to focus my interest and future career on another type of archaeology: astrophysics. The idea came to my mind unexpectedly in 2009 while visiting an exhibition called "Astri e Particelle" (Stars and Particles) at "Palazzo delle Esposizioni" in Rome. Being fascinated by the possibility to study stars and distant astrophysical processes, I attended a two weeks school in astrophysics at the IAPS (Institute for astrophysics and planetology in Rome). This helped me make the final decision to enroll for the Bachelor in Physics and Astrophysics at the University "La Sapienza" in Rome. Fascinated by cosmology and the recent preliminary results from the Planck satellite, my Bachelor thesis focused on relativistic Doppler effects on the cosmic microwave background, under the supervision of Prof. Paolo de Bernardis. A natural step was then to continue my study in this field, enrolling for the Master in Astronomy and Astrophysics in the same university, where I chose a curriculum heavily based on theoretical and observational cosmology. For my thesis, I worked again in the research group led by Prof. Paolo de Bernardis on the optimization of optical components for the polarimeter SWIPE on board of the balloon-borne experiment LSPE. The work done in the G31 laboratory

allowed me to learn more about instrumentation and experimental cosmology. During the thesis, I had the chance to work and be familiar with cryostats, microwave antennas, and low-temperature detectors. My work on the polarization properties of foam materials for polarimeters windows resulted in my first scientific publication. As much as I enjoyed the technical and experimental work, I decided that I wanted to focus more on the astrophysical side, and thus to change completely topic for my scientific career.

In October 2015 I started a position as a PhD candidate at Leiden Observatory, working under the supervision of Dr. Elena Maria Rossi on the search for hypervelocity stars in the *Gaia* catalogue. This allowed me to familiarize with big data, machine learning, spectroscopic observations, and astrometric data handling. In the four years spent in Leiden, I had the chance to travel around the world, to present my results at international conferences and visit collaborators in several institutes. I was lucky enough to travel to China, France, Germany, Greece, Hungary, UK and USA, an experience that I really enjoyed and greatly enriched my ability to efficiently communicate my scientific results to a broad audience. My works with *Gaia* data (chapters 3 and 4 of this thesis) resulted in two press releases from the European Space Agency, and had a large impact on magazines and online scientific blogs. In Leiden I have been a teaching assistant for the bachelor courses "Introduction to General Relativity and Astrophysical Applications" and "Radiative Processes". During the PhD I have also been official co-supervisor for 8 Master students at Leiden Observatory and 2 high school students in Amsterdam, an experience that has greatly improved my ability of mentoring. In April 2019 I have been guest lecturer on Machine Learning in the master course "Numerical Recipes for Astrophysics". In the first semester of 2017 I organized, together with Eleonora Zari, PhD talks, specially meant for fellow candidates to share their scientific results with their colleagues in a friendly environment. In summer 2018 I had the privilege to volunteer to the "Discover Club" programme (UNAWE): an astronomy outreach programme for children in the emergency refugee center in Katwijk (The Netherlands).

On December 1st 2019 I will start a fellowship at the European Southern Observatory Headquarters in Garching, Germany. There I will have the chance to continue my scientific career focused on high velocity stars and to expand my expertise working with some of the most important state-of-the-art telescopes.

Acknowledgements

These four years spent at Leiden Observatory flew by, and they would have not been the same without the presence of so many nice people working there. So my first acknowledgment goes to the Leiden Sterrewacht, for being such a friendly, international, positive and inclusive environment. That was the first thing that struck me back in February 2015 when I was invited for the PhD interviews, and more than four years later I'm glad that this impression was confirmed and exceeded.

I want to deeply thank Elena, for offering me this PhD position and believing in me, at a time when my background was completely different from what would have then become my own research field. I knew nothing about the Milky Way and high velocity stars, and it is thanks to you if I started my scientific career in this fascinating field of research. Thank you for your continuous availability, your constant enthusiasm in the work, for always pushing me to give my best in all the occasions, and simply for starting such an awesome research group. Thank you Alex, Clément, Fraser, Stella and Valeria for the exciting lectures, lively discussions and interesting meetings. Thanks to Anthony Brown for being my unofficial second supervisor, your expertise has been invaluable for my project. Thanks to all the master students I had the pleasure to supervise over these years: Bart, Brendon, Esmee, Luther, Marco, Omar, Tom, Yuejia. As often in science, it has not always been a linear and simple path, but I hope that you enjoyed working together as much as I did, and that some of the skills you acquired during the project have been (or will be) useful in your future careers.

A huge thanks to all the amazing people I met at the Observatory. Christos and Jit, you two are the best friends I could meet. I am sure that even if our future paths will diverge from Leiden, things among us will never change. I will miss our nights at Lemmy's, the random last-minute holiday

to Crete, the trip to India, jamming together, playing PS4, watching movies and simply chatting about life and everything. I'm so happy I have you as my best friend(s). To Ele: from supervising students and going to conferences together to hanging out, travelling, cooking and watching Italian TV shows at home, spending time with you has always been great fun. Thank you, life in Leiden would have not been the same without you. To the (extended) AstroTelegram and AstroLunch people: Aayush, Alberto, Andrej, Clément, Daniel, Dilovan, Emanuele, Francesco, Fraser, Gabriella, Gaby & Marco, Igone & David, Kim, Kirsty, Lammim, Lorenzo, Luke, Omar, Pedro, Salvatore, Santiago, Valeria, Vincenzo, thanks for all the great dinners, lunches, brunches, nights, parties, barbecues, and all kinds of social activities. Thanks Pier, daje forte sempre. To my fellow PhD friends Alex, Hiddo (thanks for helping with the Nederlandse Samenvatting), Josh, Luis, Mieke, Stijn, Stella, for all the great memories in Kaiser Lounge and at the borrels. Thanks to the Observatory band: Christos, James, Olivier and Peter, for the fun times playing together. Finally, special thanks go to Maria Cristina, for being the curious, enthusiastic and always stimulating person that you are. Thank you for the great time spent together, from the amazing trip to Morocco to everyday life. What we did is just a taste of what's yet to come.

A special thanks to all my colleagues (and friends) I met at the University "La Sapienza" in Rome during my bachelor and master: Adriano, Gabriele, Fabrizio, Francesca M., Francesca S., Luca, Michele, Pietro, Silvia, Simone, Stefano, Valerio. Without you, I would have never been able to make it through the exams, the bureaucracy, and the infinite amount of hours spent trying to give meaning to physics.

Un abbraccio speciale ai miei amici di sempre: Bea, Betta, Cella, Fede, Francesco, Gabriele, Genny, Giulio, Johnny, Miriam, Natan, Quattro, Riccardino, Riccardone, Sarella, Silvia, Tanna, Timmy, Vitto. Non è sempre semplice rimanere in contatto vista la distanza, ma ogni volta che torno a Roma è come se non fossi mai partito. Grazie per esserci sempre. Grazie ad Alice, Anna & Bruno, Livio & Marco, Luca & Irene. Ci vediamo sempre meno di quanto vorremmo, ma certi rapporti non cambiano mai. Un grazie particolare a Daniele: se non fosse stato per quel concerto allo Strike non sarei la persona che sono oggi. Grazie di cuore. Un abbraccio enorme agli Otsunami: Alex, Lorenzo, Luca e Marco. Condividere il palco con voi è stata una delle esperienze più importanti della mia vita. Quello che abbiamo cre-

ato insieme in sala è stato (e sarà) unico ed irripetibile. In particolare, grazie Marco, per le cene, i concerti, le lunghe passeggiate e le chiacchierate al parco (a Roma e a Rotterdam), un abbraccione frate.

Infine, voglio ringraziare specialmente la mia famiglia. Grazie ai miei nonni: Dina, Elide, Lorenzo e Sergio, per tutti i meravigliosi momenti passasti insieme e per tutti quelli in cui purtroppo non sono potuto essere lì con voi. Sono sicuro che sareste stati orgogliosi. Alle mie cugine Cecilia, Elisa e Flavia. A Marco, per il suo sostegno, dagli aiuti con i compiti di fisica al liceo fino alla lettura di questa tesi. Grazie per essere sempre un punto di riferimento. A mamma, per il continuo e incondizionato supporto, per i bei viaggi che continuiamo (e continueremo) a fare insieme, per le piccole litigate che ogni tanto ci piacciono tanto, e per tutte quelle altre cose che mi ci vorrebbe una tesi intera per elencarle. A papà, vorrei tanto che tu fossi qui.