Gabriele Bertinelli

MSc student in *Physics of Data*
Department of Physics and Astronomy
"Galileo Galilei"

bertinelligabriele@gmail.com
gabriele.bertinelli@studenti.unipd.it
Berto70
Berto70
Gabriele Bertinelli

Education

•Master's Degree in Physics of Data *2023 - Sept 2025*
University of Padova, Italy

•Bachelor's Degree in Astronomy *2019-2022*
University of Padova, Italy

Thesis

•MSc Thesis (in progress)

Title: "Exploring Rotational Properties and the Yarkovsky Effect in Asteroid Families: A Data-Driven Analysis"

– Supervisor: Prof. Monica Lazzarin - UniPD
– Co-Supervisor: Prof. Paolo Tanga - OCA
– Description: Asteroid rotation parameters are available for about 14,000 asteroids, from the ESA mission GAIA alone, with additional sources providing further data. A large fraction of these data remain largely unexploited, representing a unique opportunity for investigation. Specifically, I aim to analyze the rotational properties in relation to the family membership and the orbital drift associated with the Yarkovsky effect. In particular, I will focus on asteroid families with slightly different but closely spaced semimajor axes. These families often overlap in the space of osculating elements, but can exhibit distinct rotational properties. By identifying and analyzing these differences, we can improve the classification and distinction of family members, enhancing our understanding of their evolutionary history and dynamical behavior. The analysis described above will be carried out using machine learning (ML) techniques. ML is still an underexplored area of astrophysics research, and the goal is to develop knowledge and tools that can be applied in different contexts. Another goal will be to understand the possibilities and limitations that ML has with respect to data and the topic I am going to cover.

–BSc Thesis

Title: "DART mission to the Didymos binary system"

∗ Supervisor: Prof. Monica Lazzarin - UniPD
∗ Description: The purpose of this thesis is to describe the DART mission to the Didymos binary asteroid system. To do this, we start with a general description of asteroids and then move on to binary systems, important scientific targets for studying the formation and evolution of asteroids and shedding light on the evolutionary aspects of the Solar System itself. The discussion will then shift to the modalities and purposes of the DART mission, the first mission with the goal of testing a planetary defense system against potentially dangerous bodies. The system of (65803) Didymos, the target of the DART and Hera missions, will be discussed, discussing its dynamical, morphological, and spectroscopic characteristics. Finally, the first results produced by the observational campaigns, terrestrial and space-based, that began immediately after the probe's impact with the asteroid Dimorphos will be described.

Projects Accomplished during the Master's degree

–Implementation of `fireworks` Python module, Plummer sphere evolution, code optimization *2024*

The project was proposed for my Master's course 'Computational Astrophysics'

∗ Tools: Python, N-body simulations, Computational Astrophysics
∗ Goal of this project is the development of a N-body simulation Python module. Using `fireworks`, we studied the evolution of different realizations of star clusters drawn from a Plummer sphere in virial equilibrium. The cluster was evolved in orbit in a point mass potential. We analyzed the leading and trailing tidal arms and the effectiveness of the 'tidal radius criterion' in selecting stars belonging to the cluster. Alongside the simulation, we explored ways to optimize the N-body simulation code using GPUs and multithreading and multiprocessing on CPUs.

–Parallel N-Body algorithm with CUDA *2025*

The project was proposed for my Master's course 'Modern Computing for Physics'

∗ Tools: C, C++, CUDA, N-body simulations, GPU computing
∗ Goal of this project is the development of a parallel simulation of a 6-body gravitational problem in 3D space. The task involves computing the trajectories of six interacting particles under the influence of Newtonian gravity and visualizing their motion over time. The simulation is implemented using the CUDA framework.

–**Hierarchical Mergers of Binary Black Holes** *2024*

The project was proposed for my Master's course 'Laboratory of Computational Physics - A'

* Tools: Python, Jupyter Notebook, Binary Evolution, SEVN, Machine Learning
* Goal of this project is to understand the differences between hierarchical binary black hole mergers in NSCs, GCc and YSc, by looking at a set of simulated BBHs. Our analysis was carried out with classification ML algorithms, such as Random Forest and XGBoost. We proceed to analyze the importance of features to understand the properties of systems of BBHs.

–**Dormant Black Holes in Binaries from Gaia DR3** *2023*

The project was proposed for my Master's course 'Laboratory of Computational Physics - B'

* Tools: Python, Jupyter Notebook, Binary Evolution, SEVN, Machine Learning
* We explored the evolution of binary systems containing a black hole and a main sequence star using Binary System Evolution (BSE) simulations and machine learning techniques. Using a rapid binary population-synthesis code, SEVN, we simulated the evolution of these systems and compared the results to the observed properties of known binaries. Machine learning techniques were used to identify the key factors that influence the evolution of these systems.

–**Streaming processing of cosmic rays using Drift Tubes detectors** *2023*

The project was proposed for my Master's course 'Management and Analysis of Physics Dataset'

* Tools: Python, Kafka, pySpark, Bokeh
* Goal of this project is to reproduce a real-time processing of real data collected in a particle physics detector and publish the results in a dashboard for live monitoring.

–**Bayesian Blocks algorithm implementation in R** *2024*

The project was proposed for my Master's course 'Advanced Statistics for Physics Analysis'

* Tools: R, Jupyter Notebook, Bayesian Inference
* Using the R program language, a Bayesian Block algorithm implementation has been developed and tested on light curve of Supernovae explosion.

Workshops

–**Europlanet Early Career (EPEC) Annual Week 2024**
Annual Week held by the Europlanet Society. The objective of the Society is to promote the advancement of planetary science, planetary exploration and related fields. *2024*

–**International workshop on Machine Learning in Astronomy**
National Center for Big Data and Cloud Computing *2023*

–**Gravitational Wave Open Data Workshop**
GWOSC *2023*

Experiences

–**Science communicator** *2017 - Ongoing*

Link2Universe

* Editor and admin of one of the largest Italian space-releated outreach pages. Publication of space, astrophysics and science news on Facebook, Instagram and Telegram.

–**ERASMUS+ Traineeships** *March - July 2025*

Côte d'Azur Observatory - Nice, France

* During ERASMUS + mobility, I worked alongside with Paolo Tanga and its team, analyzing the property of the Yarkovsky Effect and its effect on the rotational properties of the asteroid families. *For more details look at the "Master's Thesis" section.*

–**Observations at 'Copernico' telescope** *October 2022*

Asiago Observatory - INAF OAPd

* Tools: telescope observations, Python, IRAF, DS9
* I spent three nights (October 17-19th 2022) at the Asiago Observatory, on behalf of Prof. Monica Lazzarin, observing the Dydimos system after the DART impact. I collected both photometric and spectroscopic data. I also performed a quick data cleaning and analysis using IRAF routines.

Interests

I am an astrophysicist with a strong interest in observational astrophysics, particularly focused on *minor bodies* and planetary science. My journey as a student (and aspiring researcher) is driven by a deep curiosity in harnessing the power of *machine learning* techniques in the field of astrophysics. In addition, I have a strong affinity for data science, which complements my analytical skills.

Areas of Interest: Minor bodies, Planetary science, Machine Learning, Bayesian Statistic, N-Body simulations

Languages

–**Italian**
Native
–**English**
Full professional proficiency
–**French**
Elementary proficiency

Technical Skills

Languages: Python, SQL, R, Bash, C, CUDA, IRAF
Operating Systems: Windows, Linux
Developer Tools: Jupyter Notebook, VSCode, Git, GitHub, GitLab
Frameworks: Apache Spark, Kafka, Dask
Container Applications: Docker
Visual Communication: LaTeX, Markdown, MO Power Point, MO Word
Editing softwares: Adobe Premiere Pro, Adobe Photoshop, Adobe Lightroom
Soft Skills: Teamwork oriented, Time management, Organization skills, Autonomous work