

Stefano Torniamenti

Postdoctoral researcher

Education

- Oct. 2019 - **PhD in Astronomy**, *University of Padua, cum laude*.
Apr. 2023 PhD project title: Unveiling the dynamics of young star clusters and their black hole population. Supervisor: Prof. Michela Mapelli. Co-supervisors: Dr. Alessandro Ballone and Dr. Mario Pasquato.
- Jan. - July 2022 **Visiting researcher**, *Institut de Ciències del Cosmos, Universitat de Barcelona (ICCUB)*.
Supervisor: Prof. Mark Gieles.
- Oct. 2016 - **Master in Physics**, *University of Milan, 110/110 cum laude*.
Feb. 2019 Thesis title: Energy equipartition and mass segregation in globular clusters. Supervisor: Prof. Giuseppe Bertin. Co-supervisor: Prof. Claudio Grillo.
Average class grade: 30/30 with 8/12 distinctions ("cum laude").
- Oct. 2012 - **Bachelor in Physics**, *University of Milan, 110/110 cum laude*.
Feb. 2016 Thesis title: Study of the presence of a black hole in an ultra-compact dwarf galaxy. Supervisor: Prof. Giuseppe Bertin

Academic positions

- Jan. 2025 - **Humboldt Research Fellow**, *Max Planck Institute for Astronomy*.
- Nov. 2023 - **Postdoctoral researcher, ERC consolidator DEMOBLACK/ STRUCTURES Cluster of Excellence**, *Institute for Theoretical Astrophysics, Centre for Astronomy of Heidelberg University*.
Dec. 2024
- Jan. - Oct. 2023 **Postdoctoral researcher, ERC consolidator DEMOBLACK**, *University of Padua*.

Honors/Awards

- 2024 **Juan De La Cierva Postdoctoral Fellowship**, *declined*.
- 2024 **Humboldt Research Fellowship**.
- 2022 **Fondazione Ing. Aldo Gini Fellowship**.
Awarded by Fondazione Ing. Aldo Gini, 4600€.
- 2022 **Erasmus+ Traineeship Scholarship**.
Awarded by the Erasmus programme, 2100€.

Accepted computational proposals

- Principal Investigator **PRACE DECI–17 proposal**, *StarCluBin*.
7.52M standardised hours awarded for N -body simulations on the Snellius Tier-1 supercomputer at SURFsara.
- Principal Investigator **ISCR A C (CALL 84C) proposal**, *The impact of hydrodynamical initial conditions on N -body simulations*.
32k CPU hours awarded for N -body simulations on the MARCONI100 Tier-0 cluster at CINECA.

External Funding

- co-I **PRIN INAF (200k EUR for 3 years) 2022**, *Title: Pulsar/black-hole systems and other jewels in the casket of globular cluster stellar populations*, PI: Andrea Possenti; co-PIs: Michela Mapelli, Cristina Pallanca.
- co-I **PRIN MIUR (577.5k EUR for 3 years) 2021**, *Title: Multimessenger astronomy in the Einstein Telescope Era (METE)*, PI: Marica Branchesi; co-PIs: Enrico Cappellaro, Michela Mapelli, Michele Punturo.
- Grant **IAU Grant (260 EUR)**, *Grant awarded to participate to the IAU Symposium 351 & MODEST 19*.

Conferences & Seminars

Invited talks

- 27th-28th Aug. 2024** **Autumn Physics of Data Workshop 2024**, Asiago, Italy.
Invited talk: "Understanding black holes in the era of gravitational waves".
- 12th-16th Aug. 2024** **New ideas on the ORIGIN of BLACK HOLE MERGERS**, Copenhagen, Denmark.
Invited talk: "Hierarchical and Pop. III black hole mergers in star clusters".
- 26th Mar. 2024** **ESO lunch talk**, Garching bei München, Germany.
Invited talk: "Unveiling black hole populations on open clusters".
- 3rd-7th Jul. 2023** **A multi-wavelength view on globular clusters near and far: from JWST to the ELT**, Sexten, Italy.
Invited talk: "Globular clusters and their black hole population in the era of gravitational-wave astronomy".
- 20th Apr. 2023** **Seminar at IAC**, La Laguna, Spain (online seminar).
Invited talk: "A new generative model for star clusters from hydro-dynamical simulations".
- 24th Jan. 2023** **Seminar at SISSA**, Trieste, Italy.
Invited talk: "Formation channels of binary black holes in young star clusters".
- 22nd Febr. 2022** **Seminar at Université de Montréal (UdeM)**, Montréal, Canada (online seminar).
Invited talk: "Star cluster formation: towards generative models".

Contributed talks

- 14th-18th Oct. 2024 **Challenges and future perspectives in gravitational- wave astronomy: O4 and beyond**, Leiden, The Netherlands.
Contributed panelist, discussion on eccentricity.
- 1st-5th Jul. 2024 **European Astronomical Society Annual Meeting 2024**, Padova, Italy.
Contributed talk: "Unveiling black holes in the Hyades star cluster".
- 11th-15th Sep. 2023 **Two in a million - The interplay between binaries and star clusters**, Garching bei München, Germany.
Contributed talk: "Star Clusters and the Nursery of Binary Black Holes".
- 5th-7th Sep. 2023 **MWGaia COST ACTION Final conference: "The Milky Way Revealed by Gaia: The Next Frontier"**, Barcelona, Spain.
Contributed talk: "Unveiling black holes in open clusters".
- 28th Aug. -1st Sep. 2023 **MODEST-23: Star Clusters in the Post-Pandemic Era**, Evanston, USA.
Contributed talk: "Star Clusters and the Nursery of Binary Black Holes".
- 26th-30th Jun. 2023 **The Renaissance of Stellar Black-Hole Detections in The Local Group**, Leiden, The Netherlands.
Contributed talk: "Black holes in the Hyades cluster".
- 14th-25th Nov. 2022 **MIAPbP - The Fundamental Role of Stellar Multiplicity in Stellar Dynamics and Evolution**, Garching bei München, Germany.
Contributed talk: "Formation channels of binary black holes in young star clusters".
- 26th-30th Sep. 2022 **International conference PUMA22 - Probing the Universe with Multimessenger Astrophysics**, Sestri Levante, Italy.
Contributed talk: "Binary black hole mergers in young star clusters".
- 25th-28th Apr. 2022 **AAS 53rd Annual Meeting of the DDA**, Flatiron Institute, New York.
Contributed talk: "Formation channels of binary black hole mergers in young star clusters".
- 9th-12st Nov. 2021 **IAU Symposium 362, "Predictive Power of Computational Astrophysics as a Discovery Tool"**, online edition.
Contributed talk: "A novel generative method for star clusters from hydro-dynamical simulations".
- 28th Oct. 2021 **TEONGRAV Seminar**, online seminar.
Contributed talk: "The impact of star cluster dynamics on binary black hole mergers".
- Posters**
- 11th-15th Sep. 2023 **Two in a million - The interplay between binaries and star clusters**, Garching, Germany.
Poster: "Unveiling black holes in open clusters".
- 27th Jun. - 1st Jul. 2022 **European Astronomical Society Annual Meeting 2022**, Valencia, Spain.
Poster: "Formation of young stellar clusters from turbulent molecular clouds".
Poster: "Formation channels of BBH mergers in young star clusters".

- 28th Jun. - **European Astronomical Society Annual Meeting 2021**, online edition.
2nd Jul. 2021 Poster: "Evolution of binary populations in young stellar clusters".
- 9th-11th Mar. **55th Rencontres de Moriond 2021**, *Gravitation session*, online edition.
2021 Poster: "The effect of dynamics on BBH populations".
- 27th-31st May **IAU Symposium 351 & MODEST 19**, "*Star Clusters: from the Milky Way to the Early Universe*", Bologna, Italy.
2019 Poster: "A simple two-component description of mass segregation for anisotropic globular clusters".

Teaching experience

Teaching assistant

- Oct. 2021 - **Assistant for the course: Computational astrophysics.**
Jan. 2022 Master in Astrophysics and Cosmology, University of Padova.
- Oct. 2021 - **Assistant for the course: Experiments in physics 1.**
Jan. 2022 Bachelor in Physics, University of Padova.

Supervising

- 2024 **Co-supervisor of Filippo Simonato's master thesis.**
Thesis: "Very Massive Stars and Their Compact Remnants"
- 2024 **Co-supervisor of Franca De Domenico-Langer bachelor thesis.**
Thesis: "Impact of stellar winds on the rate of pair instability supernovae and black hole mergers"
- 2022 **Co-supervisor of Francesco Flora's master thesis.**
Thesis: "Eccentricity evolution of binary black holes in globular clusters"
- 2021 **Co-supervisor of Nicolò Belgiovine's bachelor thesis.**
Thesis: "Hierarchical black hole mergers in stellar clusters"

Outreach

- Apr. 2024 **Girls' Day**, Heidelberg.
- Sep. 2021 **Researchers Night - VenetoNight 2021**, Padova.

Press Releases

- Sep. 2023 **New results hint at the existence of the closest Black Holes to Earth in the Hyades star cluster**, by *Institute of Cosmos Sciences (ICCUB)*.
[Press release link](#)

Referee work

Reviewer for the Czech Science Foundation.

Reviewer for the Astrophysical Journal (ApJ), Physical Review Journals and Nature Communications.

IT knowledge

Programming and scripting

Excellent python, C++, Wolfram Mathematica, python scientific packages (numpy, panda, scipy, matplotlib).

Good BASH scripting, Octave/Matlab, SQL, R.

Machine learning platforms

Excellent SciKit-Learn, Keras, TensorFlow.

Software and Utilities

Excellent L^AT_EX, Google suite, Office suite (Microsoft office, LibreOffice), GitHub, GitLab, Dropbox, Google suite.

Good Geopandas, Folium.

Operating systems

Excellent Windows, Linux.

Code developer

Fastcluster population-synthesis code for binary black hole dynamics in star clusters. Public version: [this link](#). The new version I implemented will be available soon (Mapelli et al. 2021, Torniamenti et al. 2024).

Advanced code user

NBODY6++GPU direct N -body code, available at [this link](#) (Wang et al. 2015).

PeTar direct N -body code, available at [this link](#) (Wang et al. 2020).

MOBSE population-synthesis code, available at [this link](#) (Giacobbo et al. 2018).

clusterBH semi-analytic model for evolving star clusters, available at [this link](#) (Antonini & Gieles 2020).

HiGPUs direct N-body code (Capuzzo-Dolcetta et al. 2012).

McLuster tool to make a star cluster, available at [this link](#) (Küpper et al. 2011).

Computing experience

Experience in high-performance and parallel computing (OpenMP).

Experience in GPU computing (CUDA parallel architecture).

Certifications

TensorFlow online four-course professional certificate "DeepLearning.AI TensorFlow Developer". Certificate ID: RDFVAFGVHL4T.

Deep Learning online five-course specialization "Deep Learning Specialization". Certificate ID: GNQPK68F5MM9.

Machine Learning online course "Machine Learning". [Certificate ID: GVNYVMDL23DU](#).

SQL online data science courses offered by Kaggle. Courses: **Intro to SQL** ([course certificate](#)), **Advanced SQL** ([course certificate](#)).

Language skills

Italian Native speaker.

English: Fluent.

French: Intermediate.

Certifications

English IELTS (2019) - Grade 7.5 (CEFR: C1).

Schools and Workshops

1st-5th Jun, 2021 **Summer School in Statistics for Astronomers XVI**, *Online school*.

Week-long virtual Summer School in statistical methodology for astronomy offered by Penn State's Center for Astrostatistics.

1st-5th Feb. 2021 **SIGRAV International School 2021**, *Online school*.

School about Physics and Astrophysics of compact objects in the context of General Relativity, organised by the Italian Society of General Relativity and Gravitation (SIGRAV).

14th-23rd Jan. 2020 **MMSchool Asiago 2020**, *Asiago*.

First Padova Excellence School of Multi-Messenger astrophysics, organized by the Department of Physics and Astronomy (DFA) of the University of Padova.

7th - 9th Jun. **First ML-INFN Hackathon**, online edition.

First edition of the Machine Learning INFN (ML-INFN) starting level hackathon.

Affiliations and Memberships

DEMOBLACK I am currently member of the ERC funded Demoblack group, led by prof. Michela Mapelli at the University of Padova.

EAS I am currently member of the European Astronomical Society.

Publications

ORCID ID: [0000-0002-9499-1022](https://orcid.org/0000-0002-9499-1022)

Publications (total, 1st author) : 21, 8
Refereed publications (total, 1st author): 19, 6
Citations (total, 1st author): 527, 71
Normalized citations (total, 1st author): 63.4, 12.3

Data from SAO/NASA Astrophysics Data System.

Refereed publications

- 2024** **Torniamenti S.**, Mapelli M., Périgois C., Arca Sedda M., Artale M. C., Dall'Amico M., Vaccaro M. P., *Hierarchical binary black hole mergers in globular clusters: mass function and evolution with redshift*, 2024, A&A, 688, A148, [link](#).
- 2023** **Torniamenti S.**, Gieles M., Penoyre Z., Jerabkova T., Wang L., Anders F., *Stellar-mass black holes in the Hyades star cluster?*, 2023, MNRAS, 524, 1965, [link](#).
- 2022** **Torniamenti S.**, Rastello S., Mapelli M., Di Carlo, U. N., Ballone, A., Pasquato, M., *Dynamics of binary black holes in young star clusters: The impact of cluster mass and long-term evolution*, 2022, MNRAS, 517, 2953, [link](#).
- 2022** **Torniamenti S.**, Pasquato M., Di Cintio P., Ballone, A., Iorio G., Artale, M.C., Mapelli, *Hierarchical generative models for star clusters from hydrodynamical simulations*, 2022, MNRAS, 510, 2097, [link](#).
- 2021** **Torniamenti S.**, Ballone, A., Mapelli, M., Gaspari, N., Di Carlo U. N., Rastello S., Giacobbo N., Pasquato M., *The impact of binaries on the evolution of star clusters from turbulent molecular clouds*, 2021, MNRAS, 507, 2253, [link](#).
- 2019** **Torniamenti S.**, Bertin G., Bianchini P., *A simple two-component description of energy equipartition and mass segregation for anisotropic globular clusters*, 2019, A&A, 632, A67, [link](#).
- 2024-
accepted Prodan G. P., Pasquato M., Iorio G., Ballone A., **Torniamenti S.**, Di Carlo U. N., Mapelli M. *A machine learning framework to generate star cluster realisations*, accepted for publication in A&A, [link](#).
- 2024 Iorio G., **Torniamenti S.**, Mapelli M., Dall'Amico M., Trani A. A., Rastello S., Sgalletta C., Rinaldi S., Costa G., Dhal-Lahtinen B. A., Escobar G. J., Korb E., Vaccaro M. P., Lacchin E., Mestichelli B., Di Carlo U. N., Spera M., Arca Sedda M. *The boring history of Gaia BH3 from isolated binary evolution*, 2024, A&A, 690, A144, [link](#).

- 2024 Mestichelli B., Mapelli M., **Torniamenti S.**, Arca Sedda M., Branchesi M., Costa G., Iorio G., Santoliquido F. *Binary black hole mergers from Population III star clusters*, 2024, A&A, 690, A106, [link](#).
- 2024 Vaccaro M. P., Mapelli M., Périgois C., Barone D., Artale M. C., Dall'Amico M., Iorio G., **Torniamenti S.** *Impact of gas hardening on the population properties of hierarchical black hole mergers in AGN disks*, 2024, A&A, 685, A51. [link](#).
- 2024 Dall'Amico M., Mapelli M., **Torniamenti S.**, Arca Sedda M., *Eccentric black hole mergers via three-body interactions in young, globular and nuclear star clusters*, 2024, A&A, 683, A186. [link](#).
- 2023 Rastello S., Iorio G., Mapelli M., Arca Sedda M., Di Carlo U. N., Escobar G. J., Shenar T., **Torniamenti S.** *Dynamical formation of Gaia BH1 in a young star cluster*, 2023, MNRAS, 526, 740, [link](#)
- 2023 Ballone A., Costa G., Mapelli M., MacLeod M., **Torniamenti S.**, Pacheco-Arias J. M., *Formation of black holes in the pair-instability mass gap: Hydrodynamical simulations of a head-on massive star collision*, 2023, MNRAS, 519, 5191, [link](#).
- 2021 Di Carlo U. N., Mapelli M., Pasquato M., Rastello S., Ballone A., Dall'Amico M., Giacobbo N., Spera M., Iorio G., Spera M., **Torniamenti S.**, Haardt F., *Intermediate mass black holes from stellar mergers in young star clusters*, 2021, MNRAS, 507, 5132, [link](#).
- 2021 Rastello S., Mapelli M., Di Carlo U. N., Iorio G., Ballone A., Giacobbo N., Santoliquido F., **Torniamenti S.**, *Dynamics of binary black holes in low-mass young star clusters*, 2021, MNRAS, 507, 3612, [link](#).
- 2021 Mapelli M., Dall'Amico M., Bouffanais Y., Giacobbo N., Spera M., Bouffanais Y., Arca Sedda M., Artale M. C., Ballone A., Di Carlo U. N., Iorio G., Santoliquido F., **Torniamenti S.**, *Hierarchical black hole mergers in young, globular and nuclear star clusters: the effect of metallicity, spin and cluster properties*, 2021, MNRAS, 505, 339, [link](#).
- 2021 Ballone A., **Torniamenti S.**, Mapelli M., Di Carlo U. N., Spera M., Rastello S., Gaspari N., Iorio, G., *From hydrodynamics to N-body simulations of star clusters: mergers and rotation*, 2021, MNRAS, 501, 2920, [link](#).
- 2020 Di Carlo U. N., Mapelli M., Giacobbo N., Spera M., Bouffanais, Y., Rastello S., Santoliquido F., Pasquato M., Ballone A., Trani A. A., **Torniamenti S.**, Haardt F., *Binary black holes in young star clusters: the impact of metallicity*, 2020, MNRAS, 498, 495, [link](#).
- 2020 Ballone A., Mapelli M., Di Carlo U. N., **Torniamenti S.**, Spera M., Rastello S., *Evolution of fractality and rotation in embedded star clusters*, 2020, MNRAS, 496, 49, [link](#).

Full list of refereed publications available at:
<https://ui.adsabs.harvard.edu/public-libraries/3jHvsCloQdK93nYjT68VjQ>

Contributions to conferences and symposia

2023 - **Torniamenti S.**, *A novel generative method for star clusters from hydro-dynamical simulations*, 2022, Proceedings of the International Astronomical Union (IAU) - IAU Symposium 362, [link](#).

2020 - **Torniamenti S.**, Bertin G., Bianchini P., *A simple two-component description of mass segregation for anisotropic globular clusters*, 2020, Proceedings of the International Astronomical Union (IAU) - IAU Symposium 351 & MODEST-19, Cambridge University Press, [link](#).

Full list of non-refereed publications available at:
<https://ui.adsabs.harvard.edu/public-libraries/jptHxDkbRKKPXh9h7u6M8g>