Europass Curriculum Vitae

Personal information

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Matteo Teodori

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Home page

Nationality
Italian

Research Interests

I am mainly interested in analytical and numerical models to study the structural, spatial, kinematic and thermal characteristics of physical systems, in particular, Lagrangian models for multi-components simulations.

Among them, we have the emission of volatiles from the surface and subsurface of planetary science targets through the Smoothed Particle Hydrodynamics approach.

Similarly, the evolution of Globular Clusters and their Multiple Populations, focusing on energy equipartition, mass segregation and evaporation through dynamical models and N-body simulations.

I am generally curious about fundamental physics and astrophysics, planetary sciences, stellar formation and evolution, dark matter, cosmology, and data analysis techniques.

Research experiences

1st Dec. 2022 - Now
PhD student in Mathematics, Physics and application for Engineering at University of Campania Luigi Vanvitelli in collaboration with **INAF - Osservatorio Astronomico d'Abruzzo** studying the dynamical evolution of Globular Clusters and their Multiple Populations through dynamical models and N-body simulations. Supervisors: Prof. Oscar Straniero and Prof. Lucio Gialanella.

1st June 2022 - 30th Nov. 2022
Studentship at INAF - IAPS entitled "Activity of study and formation of planetary structures, through modeling and/or remote sensing and/or laboratory data" concerning the projects "ExoMars", "Dawn" and "TRIS". Study of the Smoothed Particle Hydrodynamics numerical method for the simulation of volatiles emission from planetary surfaces of interest for the mentioned projects.

1st Feb. 2022 - 31th May 2022
Internship at INAF - Astronomical Observatory of Rome, finalized at learning the mathematical techniques of the "Information Field Theory" and their application to astronomical data, with reference to the high-contrast images produced within the SHARK-VIS project, an instrument intended for the LBT telescope for deep detection of exoplanets through direct images.

1st Dec. 2021 - 30th Nov. 2022
Research collaborator at the Physics Department - University of Rome "La Sapienza", concerning the study of multi-mass dynamical models for Globular Clusters.

Education

16th Nov. 2021
Master degree in Astronomy & Astrophysics, University of Rome "La Sapienza", *cum laude*. Thesis title: Gravothermal catastrophe in models of Globular Clusters with a mass distribution. Supervisor: Prof. Marco Merafina.

1st Oct. 2019	**Bachelor's degree in Physics, University of Rome "La Sapienza"**. Dissertation title: Carbon ignition curves for massive stars. Supervisor: Prof. Oscar Straniero

Collaborations

Active

– Collaboration with INAF-IAPS on the study of volatiles emission from planetary surfaces and fractures using a Smoothed Particle Hydrodynamics (SPH) approach. Member of the International Space Science Institute (ISSI) group led by Dr. Michelangelo Formisano, for the project (526) "*Thermophysical characterization of ice-rich areas on the surface of specific planetary bodies: conditions for the formation of a transient exosphere*", active in the development of SPH codes able to collaborate with Eulerian codes.

– Development of multi-mass dynamical models for Globular Clusters within the research group lead by Prof. Marco Merafina, concerning a research project entitled "*Stellar evolution and dynamical evolution in Globular Clusters: theoretic development and N-body simulations*".

Past

– Collaboration with INAF-OAR concerning the development of codes for High Contrast Imaging in the SHARK-VIS project, finalized at the direct detection of extra-solar planets.

Publications

2025	**M. Teodori**, O. Straniero, M. Merafina "Primordial Segregation in Globular Clusters: the degree of mass segregation through dynamical models", in preparation.
2025	**M. Teodori**, L. Maggioni, G. Magni, M. Formisano, M. C. De Sanctis, F. Altieri, "Plumes emission from a fracture on a planetary surface using Smoothed Particle Hydrodynamics: the case of Enceladus", Icarus, under review.
2024	**M. Teodori**, O. Straniero, M. Merafina "Energy equipartition in Globular Clusters through the eyes of dynamical models", Astronomy & Astrophysics, 691, A202, DOI: 10.1051/0004-6361/202450783, supplementary material.
2022	M. Merafina and **M. Teodori**, "Generalization of the Fokker-Planck equation for stellar orbit diffusion in multi-mass star systems", arXiv: 2205.10209, DOI: 10.48550/ARXIV.2205.10209.

As a co-author

2024	M. Formisano, M. C. De Sanctis, S. Boazman, A. Frigeri, D. Heather, G. Magni, **M. Teodori**, S. De Angelis, M. Ferrari, "Thermal modelling of the lunar South Pole: Application to the PROSPECT landing site", Planetary and Space Science, 251, 105969, DOI: 10.1016/j.pss.2024.105969.

Abstract as first author

Talks

2025 (upcoming)	**M. Teodori**, L. Maggioni, G. Magni, M. Formisano, M. C. De Sanctis, F. Altieri, E. D'Aversa, M. Ciarniello, "*A Smoothed Particle Hydrodynamics model for volatiles emission: simulations of Enceladus' plumes*", Biennial European Astrobiology Conference BEACON 2025, Reykjavik, Iceland.
3-7 Feb. 2025	**M. Teodori**, L. Maggioni, G. Magni, M. Formisano, M. C. De Sanctis, F. Altieri, E. D'Aversa, "*Modeling volatiles emission through Smoothed Particle Hydrodynamics: Enceladus' plumes*", XX Congresso Nazionale di Scienze Planetarie 2025 (CNSP2025), Pescara, Italy.
8-13 Sept. 2024	**M. Teodori**, L. Maggioni, G. Magni, M. Formisano, M. C. De Sanctis, F. Altieri, E. D'Aversa, "*Volatiles emissions from surface fractures: Enceladus' plumes through Smoothed Particle Hydrodynamics simulations*", Europlanet Science Congress 2024, Berlin, Germany, EPSC2024-55, DOI: 10.5194/epsc2024-55.
19-21 Mar. 2024	**M. Teodori**, G. Magni, M. Formisano and L. Maggioni, "*Advancements in SPH modeling for volatiles emission*", ISSI International Team Meeting, Bern, Switzerland.

16-20 Oct. 2023	**M. Teodori**, O. Straniero, M. Merafina and L. Gialanella, "*Dynamical evolution of Multiple Populations in Globular Clusters*", STARS Across the Universe, INAF - Osservatorio Astronomico di Capodimonte, Napoli, Italy, DOI: 10.5281/ZENODO.10105297.
6-10 Feb. 2023	**M. Teodori**, G. Magni, M. Formisano, M. C. De Sanctis and F. Altieri, "*Volatiles emission from a fracture on a planetary surface: a Smoothed-Particle-Hydrodynamics approach*", XVIII Congresso Nazionale di Scienze Planetarie, Perugia, Italy.
14th Nov. 2022	**M. Teodori**, "*Multi-mass collisional stellar systems models for Globular Clusters*", G11 Workshop, Physics Department, University of Rome "La Sapienza".

Posters

2025 (upcoming)	**M. Teodori**, O. Straniero, M. Merafina, "*Primordial segregation in Multiple Populations through N-body simulations and dynamical models*", Bridging scales: star clusters and their hosts from the Local to the high-z Universe, Matera, Italy.
2025 (upcoming)	**M. Teodori**, O. Straniero, M. Merafina, "*Dynamical models' view on Globular Clusters and their Multiple Populations*", European Astronomical Society Annual Meeting, Cork, Ireland.
2025 (upcoming)	**M. Teodori**, O. Straniero, M. Merafina, "*Dynamical models for exploring the energy equipartition degree and mass segregation in Globular Clusters and their Multiple Populations*", STARS II: Current Challenges, Upcoming Solutions, INAF - OAS, Bologna, Italy.
19-23 Aug. 2024	**M. Teodori**, O. Straniero and M. Merafina, "*Measuring energy equipartition in Globular Clusters with dynamical models*", MODEST-24: Exploring Dense Stellar Systems Across Cosmic Time, Nicolaus Copernicus Astronomical Center, Warsaw, Poland.
16-21 June 2024	**M. Teodori**, G. Magni, M. Formisano, L. Maggioni, M. C. De Sanctis, F. Altieri, "*Volatiles emission from the Moon's surface: a Smoothed Particle Hydrodynamics approach*", European Lunar Symposium 2024, Dumfries and Galloway, Scotland, United Kingdom. Awarded of a Travel Grant.
8-12 May 2023	**M. Teodori**, G. Magni, M. Formisano, M. C. De Sanctis, F. Altieri, "*Volatiles emission from a cavity on a planetary surface using smoothed particle hydrodynamics*", Biennial European Astrobiology Conference BEACON 2023, La Palma & Teneguia Princess Hotel on Fuencaliente, La Palma Island, Canary Islands, Spain. Awarded of a financial support for accommodation.

Abstract as co-author

Posters

2024	L. Maggioni, **M. Teodori**, G. Magni, M. Formisano, M. C. De Sanctis, F. Altieri, "*Volatiles emission from planetary fractures through a Smoothed-Particle-Hydrodynamics approach: the case of Mars*", Europlanet Science Congress 2024, Berlin, Germany, 8–13 Sep 2024, EPSC2024-312, DOI: 10.5194/epsc2024-312.
2024	M. Formisano, M. C. De Sanctis, A. Frigeri, S. Boazman, D. Heater, S. De Angelis, M. Ferrari, G. Magni, **M. Teodori**, F. Altieri, "*Numerical analysis of a south pole lunar region through a 3-D FEM model: the case of the PROSPECT landing site*", European Lunar Symposium 2024, Dumfries and Galloway, Scotland, United Kingdom.
2023	M. Formisano, G. Magni, **M. Teodori**, M. C. De Sanctis, A. Raponi, M. Ciarniello, G. Filacchione, O. Aharonson , S. Bertoli , J. Castillo-Rogez, N. Davari, A. Deutsch, C. Federico, A. Frigeri, D. Hurley, "*Thermophysical characterization of ice-rich lunar polar regions*", European Lunar Symposium 2023, Padova, Italy.

Participation to workshops

May 2025	Volatile Emissions Workshop 2025, Rome, Italy.

March 2025	11th Dust Workshop, Venice, Italy. Remote participation.
Nov. 2024	MAJIS Science Team Meeting #9, ASI, Rome, Italy.
March 2024	International Team Meeting at International Space Science Institute (ISSI), Bern, Switzerland.
Nov. 2022	G11 Workshop, Physics Department, University of Rome "La Sapienza".

Funded projects

2024	Participation as **Co-I** in the INAF MiniGrant for the project *PLUMES: Planetary fractures Lagrangian simUlations for Multi-component EmissionS*, PI: Dr. Emiliano D'Aversa. Funding Institute: **INAF**. Role: development and refinement of the SPH model.
2024	Participation in the **INAF Theory Grant** for the project *Thermophysical modeling of Permanently Shadowed Regions (PSRs) on Moon and Mercury*, PI: Dr. Michelangelo Formisano (IAPS). Funding Institute: **INAF**. Role: refinement of the SPH code and its application.
2023-2024	Participation in the project "*Thermophysical characterization of ice-rich areas on the surface of specific planetary bodies: conditions for the formation of a transient exosphere*". PI: Dr. Michelangelo Formisano. Funding Institute: **International Space Science Institute (ISSI)**. Role: development of SPH codes for volatiles emission from planetary surfaces and subsurfaces.
2022	Participation in the project "*Stellar evolution and dynamical evolution in Globular Clusters: theoretic development and N-body simulations*". PI: Prof. Marco Merafina, Funding Institute: **University of Rome La Sapienza**. Role: development of multi-mass dynamical models.

Computational resources

2025	**400k core hours** assigned for the project *N-body simulations for primordially segregated Multiple Populations in Globular Clusters*, Role: **PI**, simulations setup and analysis of results. Funding institute: INAF - USC VIII - Computing within the *Call #5 for Computing and long-term archiving resources*.

Organization of workshops

2025	Organization of a workshop to gather Italian expertise on the study of volatiles emission from planetary surfaces, to be addressed with numerical models. The workshop promotes the mobility of young researchers and PhD students and is funded by **SISP-AC** (Società Italiana di Scienze Planetarie - Angioletta Coradini).

Code/software development

Language	Description
C, Cython, Python	Smoothed Particle Hydrodynamics (SPH) code for simulating volatiles emission from planetary surfaces, tracing their dynamical and thermal evolution.
Fortran	Development of a code for obtaining equilibrium solution of a multi-mass King-like dynamical model, to describe Globular Clusters 3D and 2D observables (structural, spatial, kinematic and thermodynamic properties).
C	Development of a customized version of MCLUSTER code, to set up N-body initial conditions for Multiple Population, in the case of single and multi-mass dynamical models.
Python	Codes for analyzing and fitting globular clusters observational data concerning kinematical properties related to energy equipartition as well as surface brightness profiles.
Python	Codes for analyzing results from N-body simulations.
Python	Codes for visualization and analysis of SPH simulations results.

Fortran	Code for solving equilibrium configuration of a single-mass King-model, produce results concerning structural properties, spatial distribution, internal kinematics and thermodynamic stability (Master Thesis).
C	Code for carbon ignition curve and their analysis (Bachelor Thesis).

Coding/software experience

Programming languages	**C** intermediate level (5 yrs, Bachelor's degree thesis and courses, PhD project), **Fortran** intermediate level (3 yrs, Master thesis, PhD project), **MATLAB** (for programming) basic level (PhD course) and **Python** intermediate level (3 yrs, INAF experiences and PhD project).
Professional skills	Basic experience (2 yrs) with parallel codes and simulations: **PySPH** for hydrodynamical SPH simulations, **MCLUSTER** and **NBODY6++** respectively for setting initial conditions and run N-body simulations of Globular Clusters and their Multiple Populations.
Data analysis and visualization	Experience with **MATLAB** (6 yrs) and **Python** (3 yrs) acquired during university courses, thesis work, INAF experiences and PhD project.
Document drafting	Experience of 8 yrs with LaTeX, in particular for scientific reports, thesis, abstracts, papers and proposal drafting.
Remote control	Basic knowledge (2 yrs) of remote connection to servers for running numerical simulation using SSH and SFTP protocol or by using a remote desktop software (AnyDesk, Splashtop and TeamViewer).
Website	Basic knowledge of HTML (website customization).
Others	Intermediate experience in **Office automation** packages, in particular with software for presentation, document elaboration and spreadsheets, refined from Italian secondary school to today (around 12 yrs experience). Basic ability in managing videoconferencing.

PhD schools

24 June - 5 July 2024	INAF - Course in Computing and High Performance Computing in Astronomy & Astrophysics, Bologna, Italy.
2-6 Oct. 2023	INAF - Scientific Communication in Astronomy School, Bertinoro, Italy.

Seminars

12th June 2024	**IAPS Seminar**, "*Smoothed Particle Hydrodynamics: simulation of volatiles emission from planetary surfaces*".
16th Feb. 2023	**INAF-OAAb colloquia**, "*The interconnection between multi-mass dynamical models and multiple populations in Globular Clusters*".

Teaching experiences

Tutoring	Occasional and sometimes regular tutoring of high school students in Math and Physics.
Others	Helping out with master degree thesis work of Prof. Merafina students.

Personal skills

Mother tongue	**Italian**
Other languages	

Self-assessment
European level[*]

	Understanding		Speaking		Writing
	Listening	Reading	Spoken interaction	Spoken production	
English	B1 Independent user	B1 Independent user	B1 Independent user	B1 Independent user	B1 Independent user

[*]*Common European Framework of Reference* (CEF) level