



SEDUTA DEL COLLEGIO DEI DOCENTI DEL 37° CICLO

05 Maggio 2025

Il Collegio dei Docenti del 37° ciclo del Dottorato di Ricerca in Scienze Fisiche e Chimiche dell'Università di Palermo, regolarmente convocato in modalità telematica dal Coordinatore Prof. Marco Cannas, si riunisce sulla piattaforma Microsoft Teams alle ore 14,00 del giorno 05.05.2025 con il seguente ordine del giorno:

1) Adempimenti per l'esame finale di conseguimento del titolo di dottore di ricerca del 37° ciclo (III° sessione)

Presiede il Coordinatore Prof. Marco Cannas, svolge le funzioni di segretario il Prof. Simonpietro Agnello

Sono presenti

M. Cannas, M. Miceli, F. Ferrante, S. Agnello, D. Valenti, R. Passante, F. Ciccarello, F. Messina, G. Micela, F. Reale, R. Iaria C. Fazio, G.M. Palma, G. Lazzara, G. Marsella F. Giannici,

Sono assenti giustificati

S. Milioto, G. Buscarino, G. Cusumano, B. Militello, A. Napoli, A. Pettignano.

È presente, inoltre, il Dott. F. D'Anca in qualità di cotutor

Il Presidente, prof. M. Cannas, verificato il numero legale, dichiara aperta la seduta e passa a discutere il primo punto all'ordine del giorno:

1) Adempimenti per l'esame finale di conseguimento del titolo di dottore di ricerca del 37° ciclo (II° sessione)

Il presidente illustra gli adempimenti necessari per il conseguimento del titolo di dottore di ricerca per gli allievi del 37° ciclo che intendono sostenere l'esame finale nella terza sessione (26 Giugno – 6 Luglio 2025).

In accordo al cronoprogramma, il presente collegio dei docenti dovrà occuparsi dei seguenti punti:

- formulazione della relazione del dottorando sulle attività svolte
- formulazione del parere per il titolo di Doctor Europaeus
- proposta di formazione delle commissioni giudicatrici
- nomina dei valutatori esterni



Mohsen POURMOHAMMAD SHAHVAR

(Tutor: Prof. Giovanni Marsella)

Il collegio prende visione della relazione dell'allievo (**allegato 1 al verbale**).

Il collegio propone che la commissione giudicatrice per l'esame finale sia composta da:

Membri effettivi

- 1) **Prof. Leonardo Abbene**, Università degli Studi di Palermo, leonardo.abbene@unipa.it
- 2) **Prof.ssa Bruna Bertucci**, Università degli Studi di Perugia, bruna.bertucci@unipg.it
- 3) **Prof. Mosé Mariotti**, Università degli Studi di Padova, mose.mariotti@unipd.it

Membri Supplenti:

Prof. Riccardo Paoletti, Università degli Studi di Siena

Prof.ssa Chiara Perrina, EPFL Losanna (Svizzera)

Il collegio nomina i valutatori esterni:

- 1) **Prof. Francesco Giordano**, Università degli Studi di Bari

email: francesco.giordano@uniba.it

- 2) **Prof. Francesco De Palma**, Università del Salento

email: francesco.depalma@unisalento.it



Vincenzo Davide CARDINALE

(Tutor: Dott.ssa Giuseppina Micela; Cotutor: Dott. Gianluca Morgante, Fabio D'Anca)

Il collegio prende visione della relazione dell'allievo (**allegato 2 al verbale**).

Il collegio propone che la commissione giudicatrice per l'esame finale sia composta da:

Membri effettivi

- 1) **Prof. Giovanni Marsella**, Università degli Studi di Palermo, giovanni.marsella@unipa.it
- 2) **Prof. Emanuele Pace**, Università di Firenze, emanuele.pace@unifi.it
- 3) **Dott. Alfonso Collura**, INAF – Osservatorio Astronomico di Palermo, alfonso.collura@inaf.it

Membro supplente

Prof.ssa Costanza Argiroffi, Università degli Studi di Palermo, costanza.argiroffi@unipa.it

Il collegio nomina i valutatori esterni:

- 1) **Dott. Luca Terenzi**, INAF Osservatorio di Astrofisica e Scienza dello Spazio - Bologna
e-mail: luca.terenzi@inaf.it
- 2) **Dott. Francesco Santoli**, INAF Istituto di Astrofisica e Planetologia Spaziali - Roma
e-mail: francesco.santoli@inaf.it

Il verbale è approvato seduta stante. La seduta si chiude alle ore 14:45.

Il Presidente

Prof. Marco Cannas

Il Segretario

Prof. Simonpietro Agnello



Allegato 1

PHD IN PHYSICAL AND CHEMICAL SCIENCES, XXXVII COURSE

PhD Candidate: Mohsen Pourmohammad Shahvar

Transcript of Records

Tutor: Prof. Giovanni Marsella

Cotutor: --

Courses/school/exam scores:

1. Experimental Techniques in Astroparticle Physics by Prof. Giovanni Marsella ~ 16 Hours
2. Python and Quantum Mechanics by Prof. Salvatore Lorenzo ~ 20 Hours
3. Agent Based Modelling by Prof. Salvatore Micciche ~ 20 Hours
4. Italian Language Summer School

Research and training periods abroad

8-months at Karlsruhe Institute for Technology (KIT) in Germany

Papers published:

First Author:

Pourmohammad Shahvar, M., Scuderi, D., Valenti, D., Collura, A., Micciché, S., Farina, V., & Marsella, G. (2025). Climate change multi-risk assessment for mango cultivation in Sicily, Italy, by using Bayesian Network. *Acta Horticulture*, 1415, 135–144. <https://doi.org/10.17660/ActaHortic.2025.1415.15>

Pourmohammad Shahvar, Mohsen, Marsella, G., Roth, M., & Schmidt, D. (2025). Neural network identification of highly inclined muons in water-Cherenkov particle detectors. *Proceedings of 7th International Symposium on Ultra High Energy Cosmic Rays — PoS(UHECR2024)*, 115. <https://doi.org/10.22323/1.484.0115>

Pourmohammad Shahvar, Mohsen, Valenti, D., Collura, A., Micciche, S., Farina, V., & Marsella, G. (2025). An Integrated Hybrid-Stochastic Framework for Agro-Meteorological Prediction Under Environmental Uncertainty. *Stats*, 8(2). <https://doi.org/10.3390/stats8020030>

Scuderi, D., Pourmohammad Shahvar, M., Marsella, G., Farina, V., Lobo Rodrigo, M. G., & Normand, F. (2025). The climate of mango producing areas: a case study on three islands. *Acta Horticulture*, 1415, 25–32. <https://doi.org/10.17660/ActaHortic.2025.1415.3>

Shahvar, M. P., Scuderi, D., Valenti, D., Collura, A., Micciché, S., Farina, V., & Marsella, G. (2025). MISAR in enhancing agricultural resilience: a comprehensive approach to climate change risk management for mango farms in Sicily, Italy. *Acta Horticulture*, 1(1415), 145–154. <https://doi.org/10.17660/ActaHortic.2025.1415.16>

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Shahver, M., Buscemi, M., Incardona, S., Tripodo, G., & Marsella, G. (2022). MISAR: Proposal for "Climate Change Risk Management by improving the Individual and Social Awareness of Risk in Sicily." GARR-Conf22, 31 <https://doi.org/https://doi.org/10.26314/GARR-Conf22-proceedings-05>

Incardona, S., Tripodo, G., Buscemi, M., Shahver, M. P., & Marsella, G. (2023). A new Neural Network architecture for Time Series Classification. *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, 1047, 167818.

Collaborated Author:

Abdul Halim, A., Abreu, P., Aglietta, M., Allekotte, I., Almeida Cheminant, K., Almela, A., Alvarez-Muñiz, J., Ammerman Yebra, J., Anastasi, G. A., Anchordoqui, L., Andrada, B., Andringa, S., Aramo, C., Araújo Ferreira, P. R., Arnone, E., Arteaga Velázquez, J. C., Asorey, H., Assis, P., Avila, G., ... Zavrtanik, M. (2023). Constraining the sources of ultra-high-energy cosmic rays across and above the ankle with the spectrum and composition data measured at the Pierre Auger Observatory. *Journal of Cosmology and Astroparticle Physics*, 2023(05), 024. <https://doi.org/10.1088/1475-7516/2023/05/024>

Abdul Halim, A., Abreu, H., Aglietta, M., Bister, T., Bwembya, A., de Jong, S. J., Eman, M., Felcke, H., Fodran, T., Galea, C., & others. (2023). *Study of downward Terrestrial Gamma-ray Flashes with the surface detector of the Pierre Auger Observatory.*

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Abdul Halim, A., Abreu, P., Aglietta, M., Allekotte, I., Almeida Cheminant, K., Almela, A., Aloisio, R., Alvarez-Muñiz, J., Ammerman Yebra, J., Anastasi, G. A., & others. (2024b). Testing hadronic-model predictions of depth of maximum of air-shower profiles and ground-particle signals using hybrid data of the Pierre Auger Observatory. *Physical Review D*, 109(10), 102001.

Abdul Halim, A., Abreu, P., Aglietta, M., Allekotte, I., Cheminant, K. A., Almela, A., Aloisio, R., Alvarez-Muñiz, J., Yebra, J. A., Anastasi, G. A., & others. (2024a). Demonstrating agreement between radio and fluorescence measurements of the depth of maximum of extensive air showers at the Pierre Auger Observatory. *Physical Review Letters*, 132(2), 21001.

Abdul Halim, A., Abreu, P., Aglietta, M., Allekotte, I., Cheminant, K. A., Almela, A., Aloisio, R., Alvarez-Muñiz, J., Yebra, J. A., Anastasi, G. A., & others. (2024b). Inference of the Mass Composition of Cosmic Rays with energies from 5×10^{17} to 5×10^{20} eV using the Pierre Auger Observatory and Deep Learning.

Abdul Halim, A., Abreu, P., Aglietta, M., Allekotte, I., Cheminant, K. A., Almela, A., Aloisio, R., Alvarez-Muñiz, J., Yebra, J. A., Anastasi, G. A., & others. (2024c). Measurement of the Depth of Maximum of Air-Shower Profiles with energies between 5×10^{17} and 5×10^{20} eV using the Surface Detector of the Pierre Auger Observatory and Deep Lea.

Abdul Halim, A., Abreu, P., Aglietta, M., Allekotte, I., Cheminant, K. A., Almela, A., Aloisio, R., Alvarez-Muñiz, J., Yebra, J. A., Anastasi, G. A., & others. (2024d). Radio measurements of the depth of air-shower maximum at the Pierre Auger Observatory. *Physical Review D*, 109(2), 22002.

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Abdul Halim, Adila, Abreu, P., Aglietta, M., Allekotte, I., Almeida Cheminant, K., Almela, A., Aloisio, R., Alvarez-Muniz, J., Ammerman



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- Abdul Halim, Adila, Abreu, P., Aglietta, M., Allekotte, I., Almeida Cheminant, K., Almela, A., Aloisio, R., Alvarez-Muniz, J., Ammerman Yebra, J., Anastasi, G. A., & others. (2023b). Depth of maximum of air-shower profiles: testing the compatibility of the measurements at the Pierre Auger Observatory and the Telescope Array. *38th International Cosmic Ray Conference (ICRC2023)-Cosmic-Ray Physics (Indirect, CR)*, 249.
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- Bellido, J., Halim, A. A., Abreu, P., Aglietta, M., Allekotte, I., Cheminant, K. A., Almela, A., Aloisio, R., Alvarez-Muniz, J., Yebra, J. A., & others. (2024). The fitting procedure for longitudinal shower profiles observed with the fluorescence detector of the Pierre Auger Observatory. *PoS: Proceedings of Science*.
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Binet, V., Micheletti, M. I., & others. (2023). *A Catalog of the Highest-energy Cosmic Rays Recorded during Phase I of Operation of the Pierre Auger Observatory.*

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Buscemi, M. (2023). *A detailed presentation of the highest-energy cosmic rays recorded at the Pierre Auger Observatory.* *EPJ Web of Conferences*, 283.

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Castellina, A. (2023). *Astroparticle and particle physics at ultra-high energy: Results from the Pierre Auger Observatory.* *SciPost Physics Proceedings*, 13, 34.

Colalillo, R., Halim, A. A., Abreu, P., Aglietta, M., Alekotte, I., Cheminant, K. A., Almela, A., Aloisio, R., Alvarez-Muñiz, J., Yebra, J. A., & others. (2024). *Study of downward Terrestrial Gamma-ray Flashes with the surface detector of the Pierre Auger Observatory.* *PoS: Proceedings of Science.*

Collaboration, P. A. (2022). *Searches for Ultra-High-Energy Photons at the Pierre Auger Observatory.* *Universe*, 8(11), 579.

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de Oliveira Franco, D., Abdul Halim, A., Abreu, H., Aglietta, M., Bister, T., Bwembya, A., de Jong, S. J., Eman, M., Falcke, H., Fodran, T., & others. (2023). *Search for evidence of neutron fluxes using Pierre Auger Observatory data.*

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- Fitoussi, T., Abdul Halim, A., Abreu, H., Aglietta, M., Bister, T., Bwembya, A., de Jong, S. J., Eman, M., Falcke, H., Fodran, T., & others. (2023). *Depth of Maximum of Air-Shower Profiles above 1017.8 eV Measured with the Fluorescence Detector of the Pierre Auger Observatory and Mass Composition Implications*.
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- Gottowik, M., Abdul Halim, A., Abreu, H., Aglietta, M., Bister, T., Bwembya, A., de Jong, S. J., Eman, M., Falcke, H., Fodran, T., & others. (2023). *Measuring the muon content of inclined air showers using AERA and the water-Cherenkov detector array of the Pierre Auger Observatory*.
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- Zapparrata, O., Abdul Halim, A., Abreu, H., Aglietta, M., Bister, T., Bwembya, A., de Jong, S. J., Eman, M., Falcke, H., Fodran, T., & others. (2023). *The Time Evolution of the Surface Detector of the Pierre Auger Observatory.*

Conferences/workshop attended:

Main Speaker at Eventi GARR2022 – “MISAR: Climate change risk management through improving individual and social risk awareness in Sicily” https://www.garr.it/it/chi-siamo/documenti/selected-papers/selected-papers-conferenza-2022/6086-conferenza-2022-selected-papers-05-shahvar
Main Speaker at XIII International Mango Symposium 2023 -“Climate change multi-risk assessment for mango cultivation in Sicily, Italy by using bayesian network” https://mangobase.org/downloads/PDFs/mango_2023_book_of_abstracts.pdf
Main Speaker at XIII International Mango Symposium 2023 -“MISAR in agricultural area by developing machine learning models (Case Study: Mango Farms in Sicily, Italy)” https://mangobase.org/downloads/PDFs/mango_2023_book_of_abstracts.pdf
Co-Author Speaker at XIII International Mango Symposium 2023 - “The climate of mango producing areas: a case study on three islands” https://mangobase.org/downloads/PDFs/mango_2023_book_of_abstracts.pdf
Main Speaker at DPG2024 Germany – “Neural network identification of highly inclined muons in water-Cherenkov particle detectors” https://karlsruhe24.dpg-tagungen.de/programm/assets/ka24book.pdf
Poster-First Author – at UHCER 2024 Argentina - “Neural network identification of highly inclined muons in water-Cherenkov particle detectors” https://indico.ahuekna.org.ar/event/768/contributions/460/



Thesis title:

Machine Learning-Driven Solutions for Enhancing Agricultural Sustainability: The Case of Mango Farms in Sicily

Abstract:

This thesis explores the innovative application of machine learning models developed for astrophysical research to address pressing challenges in agriculture, specifically mango farming in Sicily. It highlights how advanced techniques initially designed for detecting cosmic phenomena, such as inclined muons in water-Cherenkov detectors, were successfully adapted to optimize mango cultivation under the stresses of climate change. The research bridges two seemingly unrelated fields, demonstrating the transformative potential of interdisciplinary innovation.

Key machine learning models such as ResNet + XGBoost, LSTM, Transformer, and Bayesian Networks, were adapted from their astrophysical origins to agricultural contexts, addressing critical tasks like temperature prediction, wind behavior forecasting, and multi-risk assessment for mango farming. These models, integrated with real-time sensor networks and decision-support systems, provided actionable insights for farmers, enabling optimized resource allocation, enhanced crop resilience, and sustainable farming practices.

The thesis underscores the shared complexities of astrophysics and agriculture, including processing large-scale data, predicting under uncertainty, and identifying spatial and temporal patterns. The successful transfer and adaptation of these techniques not only improved agricultural decision-making but also highlighted the potential for broader applications in other domains, such as environmental conservation and renewable energy.

The findings pave the way for scalable solutions to global sustainability challenges, demonstrating how technology designed to explore the cosmos can be repurposed to safeguard food security on Earth. This work serves as a testament to the power of interdisciplinary research, offering a roadmap for innovative, data-driven approaches to climate resilience and sustainable agriculture.

The PhD Board Dean

Prof. Marco Cannas



Allegato 2

PHD IN PHYSICAL AND CHEMICAL SCIENCES, XXXVII COURSE

PhD Candidate: Vincenzo Davide Cardinale

Transcript of Records

Tutor: Giuseppina Micela

Cotutor: Gianluca Morgante; Fabio D'Anca

Courses/school/exam scores:

Exams:

- Project Management in the Scientific-Spatial Context (Score:A)
- Product Assurance in the Space Business (Score: A)
- EXPOSURE (EXoPlanet Origins and Stellar Ultraviolet Regime Explorer): A new ESA Mission Concepts for Exoplanetary Science (Score: A)

Schools and Training:

- ESA Academy's Product Assurance Awareness Training Course (May 23-26, 2023) ESA Education Training Center in ESEC-Galaxia, Transinne, Belgium
- Summer School Alpbach 2023 "Exoplanets: Understanding alien worlds in diverse environments" (July 11 – 20, 2023) Alpbach/Tyrol – Austria
- ESA Academy's Post-Alpbach Summer School Event 2023 (November 20-24, 2023) ESA Education Training Center in ESEC-Galaxia, Transinne, Belgium

Talks:

- Exploring Space: Research, Technologies and Opportunities. The Challenges You Don't See
17 OCT 2024 AISF's event "Rock the Science" - Villa Filippina, Piazza San Francesco di Paola, 18 Palermo (PA)-
- Thermal Architecture of the ESA ARIEL payload: A softwares Comparison
18 APR 2023 EXOPA Research Group Meeting - INAF- Osservatorio Astronomico di Palermo
Giuseppe S. Vaiana (OAPa)-

Research and training periods abroad

- Six months activity at UCL Centre for Space Exo-chemistry Data (UK)
- Six months activity at ZERICAD DI FILIZZOLO MAURIZIO (Palermo, IT)



Papers published:

EXODUS: A mission proposal to explore exoplanet evolution through understanding Atmospheric Escape - *Advances in Space Research, UNDER PEER REVIEW*

Thermal Optimization Study for ZERICAD Injection Mold Design – *Technical Report INAF, IN PREPARATION*

Thermal Design for a Space Mission Exploring Exoplanet Evolutionary Processes – *Technical Report INAF, IN PREPARATION*

Modal analysis of Ni-P coated cryogenic mirrors for the Ariel mission - Presentation accepted as first author for "Astronomical Optics: Design, Manufacture, and Test of Space and Ground Systems V" session at the SPIE Optics + Photonics 2025 conference, which will be held in person in San Diego from 3 to 7 August 2025.

Cryo-facility project for Ariel M1 tests - Presentation accepted as a co-author for "Astronomical Optics: Design, Manufacture, and Test of Space and Ground Systems V" session at the SPIE Optics + Photonics 2025 conference, which will be held in person in San Diego from 3 to 7 August 2025.

Modal Analysis of Ni-P Coated Cryogenic Mirrors for the Ariel Mission, OAPA Test Plan
-Doc Ref: ARIEL-INAF-PL-PL-028; Issue: 1.0; Date: 27 January 2025-

Conferences/workshop attended:

- LEIDEN 2025 ARIEL CONSORTIUM MEETING
8 APR 2025 – 12 APR 2025 SRON Netherlands Institute for Space Research - Leiden (the Netherlands)-
- 4th MEETING OF THE ITALIAN COMMUNITY DEDICATED TO ARIELS' SCIENTIFIC PREPARATION
20 MAY 2024 – 20 MAY 2024 Best Western Ai Cavalieri Hotel -Palermo (ITALY)-
- LA LAGUNA 2023 ARIEL CONSORTIUM MEETING
6 JUN 2023 – 9 JUN 2023 IACTEC facilities & IAC Headquarters -Tenerife, Canary Islands (Spain)-
- 3rd MEETING OF THE ITALIAN COMMUNITY DEDICATED TO ARIELS' SCIENTIFIC PREPARATION
16 MAY 2023 – 18 MAY 2023 CAMPLUS PALERMO - Palermo (ITALY) –
- ARIEL CONSORTIUM MEETING DI BOLOGNA
10 OCT 2022 – 12 OCT 2022 INAF/OAS Conference Centre of the Bologna CNR Research Area - Bologna (ITALY) -
- Seminars organized by the Astronomical Observatory of Palermo:
 - L'analisi delle atmosfere degli esopianeti. Come e perché – Valerio Fardella(UNIPA)- 17/02/2022



UNIVERSITÀ DEGLI STUDI DI PALERMO
DOTTORATO DI RICERCA IN SCIENZE FISICHE E CHIMICHE

- Milky Way's young substellar population -Victor Almendros Abad (CENTRA, Faculdade de Ciencias da Universidade de Lisboa; European Southern Observatory) - 6/06/2022
- The Photographic Zenith tube(PZT) of the Neuchatel Observatory: Achievement of time determination or failure of innovation? – Julien Gressot (Université de Neuchatel, Switzerland)- 9/06/2022
- Atmospheric retrievals in the era of next generation telescopes – Quentin Changeat (UCL)- 21/06/2022
- Multicolor variability of young stars across the mass spectrum – Laura Venuti (SETI Institute)- 27/06/2022
- The supernova remnant SN1006 as a Galactic particle accelerator - R. Giuffrida(UNIPA)- 6/09/2022
- A spatially resolved study of hard X-ray emission in Kepler's SNR: indications of different regimes of Particle acceleration – Vincenzo Sapienza (UNIPA)-14/09/2022
- Feedback from Supernova Remnants: triggering Star Formation in the ISM – Giuliana Cosentino (Chalmers University of Technology, SE) -8/11/2022
- Mauve and Twinkle: UV and infrared satellites delivered through a new model – Marcell Tessenyi (BSS Italia) -14/11/2022
- Exoplanetary Atmospheres with GIANO @TNG – Gloria Guilluy (INAF-OATo)-25/11/2022
- Fast growth and feedback of black holes accreting beyond the Eddington limit – Ciro Pinto (INAF/IASF- Palermo) -15/12/2022
- Domicili cosmici–Lontani pianeti ai confini dello sguardo – Angelo Adamo (INAF/IASF- Palermo), presented by Antonino D'Ai (INAF/IASF-Palermo)-16/12/2022
- Agenzie spaziali e telescopi spaziali: un passato di grande successo, un futuro incerto – Fabio Favata(ESA) - 11/01/2023
- The three regimes of atmospheric evaporation for super-Earths and sub-Neptunes – Dariusz Modirrousta- Galian (YaleUniversity)-12/01/2023
- Misura del raggio degli esopianeti. – Mario Lauriano(UNIPA)-16/02/2023
- Mitigation of the impact of stellar activity on observations of transiting planets -Gianluca Cracchiolo (UNIPA) - 6/03/2023
- Comunicazione@INAF– Caterina Boccato, Marco Galliani, Marco Malaspina (INAF)- 10/03/2023
- Nati sotto il segno di Dike, cresciuti con quello della Bilancia – La storia della Space Law, tra gravità e giurisprudenza – Angelo Adamo (INAF)-11/05/2023
- The optical 2D and 3D correlation and their application as cosmological tool – M. G. Dainotti (National Astronomical Observatory of Japan)-14/06/2023
- The mass determination challenge for exoplanetary science - Claudia Di Maio (UNIPA/INAF)- 22/06/2023
- L'affresco dimenticato: celebrazione di una scoperta – Manuela Coniglio (INAF)-28/06/2023
- Coronal heating diagnostics from future MUSE spectroscopic observations – Paola Testa (CfA) - 12/07/2023
- Modern Diagnostic Techniques for Stellar Atmospheres – David Pascoe (University of St Andrews)-28/09/2023
- Applicazione di tecniche statistiche per la previsione della temperatura effettiva di stelle giovani – Marco Tarantino (UNIPA)- 4/10/2023
- Anisotropies in core-collapse supernova explosions: modeling the evolution of a magneto-rotational supernova remnant – Giorgio La Malfa (UNIPA)- 5/10/2023
- EWOCS: status of the project – Mario G. Guarcello (INAF) -12/10/2023



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- New larger sample of Supernova Remnants in NGC 7793, using MUSE IFS – Maria Kopsacheili (ICE-CSIC)- 18/10/2023
- Jitter radiation as an alternative for the nonthermal filaments in Supernova Remnants – Emanuele Greco (INAF)-9/11/2023
- EWOCS: The X-ray properties of the Wolf-Rayet stars in the young massive star cluster Westerlund 1 – Konstantina Anastasopoulou (INAF)-15/11/2023
- Exploring Extreme Exoplanets and Stellar Activity with Small Satellite Missions – Kevin France (University of Colorado at Boulder) -1/12/2023
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- Le spedizioni scientifiche dell'osservatorio di Palermo, ieri ed oggi – Ileana Chinnici (INAF)- 21/02/2024
- Laboratory Astrophysics with intense Lasers – Julien Fuchs (LULI, CNRS, Ecole Polytechnique, Paris, France)- 22/02/2024
- Evolution of the mass accretion rate and its relationship with the stellar and disk mass from Brown Dwarfs to stars – Victor Almendros (INAF) – 27/02/2024
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- Insights into the M-Dwarf radius and density valley – Andrea Bonfanti (Austrian Academy of Sciences, Graz, Austria) -8/05/2024
- Il cerchio di Ramsden, un prodigio tecnologico – Filippo Mirabella (INAF)- 16/05/2024
- SHARP- A Near-IR Multi-mode Spectrograph Conceived for the Multi-Conjugate Adaptive Optics Module MORFEO@ELT – Paolo Saracco (INAF)- 27/05/2024
- “Time” and Physics: A strange marriage and more... - Salvatore Sciortino (INAF)- 20/06/2024
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- The Extraordinary X-Ray flares from Young Suns – Eric Feigelson – 7/11/2024
- Italian Mission to Crimea to observe the Solar Eclipse of August 1914 – Oleh Petruk, Ileana Chinnici (INAF)- 13/11/2024
- L'Astrolabio. Uno strumento in viaggio nel tempo e nello spazio. Il ruolo della Sicilia, ponte tra le culture del Mediterraneo. – G. Truffa (History of Science Society) - 28/11/2024
- First Results from two studies of Star-Forming Regions with the WEBB Telescope – Pat Hartigan (Rice University)- 4/12/2024
- Supernova Remnants in Radio: a Multiple Approach – Adriano Ingallinera (INAF)- 5/12/2024

Seminar series attended online organized by the National Academy of Sciences (or the XL):

- Il futuro della scienza spaziale in Europa – Luigi Colangeli (ESA-European Space Agency)- 30/09/2022
- La New Space Economy: sfide e opportunità che cambieranno la società – Maria Cristina Falvella (ASI- Agenzia Spaziale Italiana)-7/10/2022



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- **La ricerca della vita con l'esplorazione del sistema solare – Maria Cristina De Sanctis (INAF)-17/10/2022**
- **Astronomia dallo spazio – Massimo Stiavelli (Space Telescope Science Institute)-21/10/2022**
- **Andare nello spazio per misurare il passato remoto dell'universo – Paolo De Bernardis (Sapienza Università di Roma)-3/11/2022**
- **Astrofisica dei raggi gamma dallo spazio – Marco Tavani (INAF-Istituto Nazionale di Astrofisica)-7/11/2022**
- **Come studiare con i raggi X l'universo violento e la fisica in condizioni estreme – Paolo Soffitta (INAF- Istituto Nazionale di Astrofisica)-18/11/2022**
- **Pianeti extrasolari dallo spazio – Giovanna Tinetti (UCL- University College London)-22/11/2022**
- **Fisica delle astroparticelle con AMS-02 sulla Stazione Spaziale Internazionale – Roberto Battiston (Università degli Studi di Trento)-28/11/2022**
- **Onde gravitazionali dallo spazio – Stefano Vitale (Università degli Studi di Trento)-12/12/2022**
- **AI il nuovo alleato delle scienze della vita– Francesca Buffa (Dipartimento di Scienze Informatiche dell'Università Bocconi)-20/10/2023**
- **Il futuro dell'espressione: esplorando le potenzialità delle tecnologie generative. – Debora Nozza (Università Bocconi di Milano)-12/12/2023**
- **L'approccio fisico-matematico all'intelligenza artificiale – Pierluigi Contucci (Università di Bologna)-15/12/2023**
- **Entanglement quantistico, connettività e il problema quantum gravity – Francesco De Martini (Accademia Nazionale dei Lincei)-21/12/2023**
- **Proteine, Proteomica e beni culturali– Gennaro Marino (Napoli Federico II)-25/01/2024**
- **Il Tempo dell'Universo - Prof. Paolo de Bernardis (Università La Sapienza di Roma) – 23/03/2024**
- **La meccanica quantistica è intuitiva, al di fuori della modellistica classica! - Thierry Paul (CNRS-Laboratoire Ypatia des Sciences Mathématiques) - 18/04/2024**
- **La decarbonizzazione dei trasporti. - Prof. Nicola Armaroli (CNR) - 30/05/2024**
- **Luce, atomi e misura del tempo - Prof. Massimo Inguscio - 2/07/2024**
- **Origine e diffusione di Homo sapiens, con ... ibridazioni interspecifiche - Prof.ssa Olga Rickards (Università degli Studi di Roma Tor Vergata) – 9/12/2024**



Thesis title:

Design, Modeling and Thermal Analysis of Space Instrumentation: Investigating Advanced Strategies for Enhanced Performance and Reliability

Abstract:

This doctoral thesis, *Design, Modeling, and Thermal Analysis of Space Instrumentation: Investigating Advanced Strategies for Enhanced Performance and Reliability*, presents a comprehensive study of thermal control systems (TCS) for space missions, with a focus on exoplanetary exploration. The research integrates theoretical modeling, numerical simulations, and experimental validation to address critical challenges in thermal management for spacecraft payloads operating in extreme environments. The work includes the following key aspects:

1. **Mission Design & Thermal Control:** Feasibility analysis of thermal architectures for two ESA mission concepts—*EXPOSURE* (UV exoplanet spectroscopy) and *EXODUS* (NIR atmospheric escape studies)—emphasizing passive cooling, multi-layer insulation (MLI), and radiator optimization for L2 Lagrange point orbits. This part adopts an analytical approach to estimate the thermal requirements of the two missions to reach the scientific requirements.
2. **ARIEL Mission Analysis:** Thermal modeling of ESA's *Atmospheric Remote-sensing Infrared Exoplanet Large-survey* (ARIEL) payload using ANSYS and ESATAN-TMS, validating cryogenic (<50 K) stability via V-groove radiators and bipod thermal isolators. This numerical analysis allowed to compare the potentialities of a simplified analysis with the finite element (FEM) and lumped parameter (TMM) approaches.
3. **Material Characterization:** Experimental modal analysis of Ni-P coated aluminum mirrors under cryogenic conditions (77 K), quantifying Young's modulus shifts and frequency response for ultra-stable space telescope applications. This chapter integrates an experimental approach with the numerical analysis and modeling to derive the material properties.
4. Finally, the thesis includes **an application of the thermal analysis methods to a non-spatial industrial context**. Experimental-computational validation of ZeriCAD injection molds with conformal cooling channels, demonstrating $\pm 2^{\circ}\text{C}$ thermal uniformity and 22% cycle time reduction for engineering thermoplastics (TPU/PEEK) under industrial processing conditions (ISO 294-4).

Keywords: Spacecraft thermal control, Exoplanet missions, Cryogenic systems, Finite element analysis, ARIEL, Modal analysis, Material characterization.

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