SEDUTA DEL COLLEGIO DEI DOCENTI DEL 38° - 41° CICLO

16 Dicembre 2025

Il Collegio dei Docenti del 38° - 41° ciclo del Dottorato di Ricerca in Scienze Fisiche e Chimiche dell'Università di Palermo, regolarmente convocato dal Coordinatore Prof. Marco Cannas, si riunisce alle ore 14,30 del giorno 16.12.2025 con il seguente ordine del giorno:

1) **Adempimenti per l'esame finale di conseguimento del titolo di dottore di ricerca del 38° ciclo (II° sessione)**
2) **Nomina dei Tutor/Cotutor per gli allievi titolari di borsa Marie Skłodowska-Curie Actions- Doctoral Networks**

Presiede il Coordinatore Prof. Marco Cannas, svolge le funzioni di segretario il Prof. Giuseppe Lazzara

Sono presenti

Marco Cannas, Francesco Ferrante, Michelangelo Scopelliti, Fabrizio Lo Celso, Fabio Bagarello, Giuseppe Lazzara, Giuseppe Cavallaro, Manuela Mallamaci, Salvatore Miccichè, Davide Valenti Alberto Pettignano, Marco Miceli, Francesco Giannici, Lorenzo Lisuzzo, Melania Del Santo, Paolo Pagano, Umberto De Giovannini, Salvatore Lorenzo

Sono assenti giustificati Tiziana Di Salvo, Serena Benatti, Lucia Rizzuto, Mauro Paternostro, Giovanni Marsella, Gioacchino Massimo Palma, Roberto Passante, Rosario Iaria, Antonino D'Ai, Luca Innocenti, Gianpiero Buscarino, Stefana Milioto, Simonpietro Agnello, Alice Sciortino, Francesco Ciccarello, Fabrizio Messina, Angelo Carollo, Fabio Reale, Claudio Fazio, Luciano Burderi, Giuseppina Micela, Dario Duca

Sono inoltre presenti i Dott. Ciro Pinto, Marco Reale, Gabriele Lo Monaco 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 38° ciclo (II° sessione)

Il presidente illustra gli adempimenti necessari per il conseguimento del titolo di dottore di ricerca per gli allievi del 38° ciclo che concludono il loro dottorato il 31 ottobre 2025 e intendono sostenere l'esame finale nella seconda sessione (20 Febbraio – 03 Marco 2026).

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

Carotenuto Maria Rosalia

(Tutor: Prof. Giuseppe Cavallaro; Co-Tutor: Dott.ssa I. Chinnici)

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) Dott. Lorenzo Lisuzzo, Università degli Studi di Palermo, lorenzo.lisuzzo@unipa.it

2) Prof. Ignazio Blanco, Università di Catania

3) Prof.ssa Sabrina Grassini, Politecnico di Torino

Membri supplenti

Prof. Francesco Ferrante, Università degli Studi di Palermo

Prof. Francesco Armetta, Università degli Studi di Palermo

Il collegio nomina i valutatori esterni:

1) **Chiara Pelosi -** Università di Pisa, Dipartimento di Chimica e Chimica Industriale email chiara.pelosi@unipi.it)

2) Emma Angelini - Politecnico di Torino, Dipartimento Scienza Applicata e Tecnologia email: emma.angelini@formerfaculty.polito.it

Ferlito Chiara

(Tutor Prof. Giuseppe Lazzara, Cotutor: Dott. Marco Bertini)

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

Il collegio propone che la commissione giudicatrice sia composta da:

Membri effettivi

1) Prof. Francesco Giannici, Università degli Studi di Palermo, francesco.giannici@unipa.it

2) Dr. Bojana D. Blagojevic, University of Novi Sad, Faculty of Agriculture (Serbia)

3) Dr. Pavel Šiler, Brno University of Technology , Faculty of Chemistry (Repubblica Ceca)

Membro supplente

Prof. Alberto Pettignano, Università degli Studi di Palermo

Prof.ssa Maria Luisa Saladino, Università degli Studi di Palermo

Il collegio nomina i valutatori esterni:

1) Tadas Dambrauskas, Kaunas University of Technology, Faculty of Chemical Technology – Lituania

email: tadas.dambrauskas@ktu.lt

2) Eleni Gianni, Ionian University, Department of Enviornment – Grecia

email: e.gianni@ionio.gr

Inoltre, per l'allieva Chiara Ferlito, il collegio attesta che sono soddisfatti i criteri per conseguire il titolo di **Doctor Europaeus**, ed **esprime un parere positivo.**

Castronovo Pietro

(Tutor: Prof. Fabrizio Messina, Cotutor: Dott.ssa Alice Sciortino)

Il collegio prende visione della relazione dell'allieva (**allegato 3 al verbale**).

Il collegio propone che la commissione giudicatrice sia composta da:

Membri effettivi

1) Prof. Simonpietro Agnello, Università degli Studi di Palermo, simonpietro.agnello@unipa.it

2) **Prof. Claudio Giannetti**, Università Cattolica del Sacro Cuore, Brescia

3) **Prof. Thomas Kraus,** Leibniz-Institut für Neue Materialien gGmbH, Germa

Membri supplenti

Prof. Francesco Giannici, Università degli Studi di Palermo

Prof. Carlo Maria Carbonaro, Università degli Studi di Cagliari

Il collegio nomina i valutatori esterni:

1) Thomas Kodger, Wageningen University & Research, The Netherlands

email: thomas.kodger@wur.nl

2) Jochen Feldmann, Ludwig-Maximilians-University (LMU, Munich, Germany.

email: feldmann@lmu.de

Inoltre, per l'allievo Pietro Castronovo, il collegio attesta che sono soddisfatti i criteri per conseguire il titolo di **Doctor Europaeus**, ed **esprime un parere positivo.**

Virga Simone

(Tutor: Prof. Francesco Giannici, Cotutor: Dott. Alessandro Longo)

Il collegio prende visione della relazione dell'allieva (**allegato 4 al verbale**).

Il collegio propone che la commissione giudicatrice sia composta da:

Membri effettivi

1) **Prof. Giuseppe Lazzara**, Università degli Studi di Palermo, giuseppe.lazzara@unipa.it

2) **Prof. Lorenzo Malavasi**, Università di Pavia

3) **Prof. Lorenzo Stievano,** Université de Montpellier, Fance.

Membri supplenti

Prof. Francesco Ferrante, Università degli Studi di Palermo

Prof.ssa Silvia Gross, Università di Padova

Il collegio nomina i valutatori esterni:

1) Maria Alfredsson, University of Kent, UK

email: m.l.alfredsson@kent.ac.uk

2) Vladimir V. Galvita, Ghent University, Belgio

email: vladimir.galvita@ugent.be

Inoltre, per l'allievo Simone Virga, il collegio attesta che sono soddisfatti i criteri per conseguire il titolo di **Doctor Europaeus**, ed **esprime un parere positivo.**

Alaimo Edoardo

(Tutor: Prof. Fabio Reale, Cotutor: Prof. Marco Barbera)

Il collegio prende visione della relazione dell'allieva (**allegato 5 al verbale**).

Il collegio propone che la commissione giudicatrice sia composta da:

Membri effettivi

1) Prof. Giovanni Marsella, Università degli Studi di Palermo giovanni.marsella@unipa.it

2) Prof. Francesco Malara, Università della Calabria

3) Prof.ssa Maria Guglielmina Pelizzo, Università degli Studi di Padova.

Membri supplenti

Prof. Enrico Bozzo, University of Geneva

Prof. Berend Winter, University College London

Il collegio nomina i valutatori esterni:

1) Daniele BRIENZA, ASI - Agenzia Spaziale Italiana

email: daniele.brienza@asi.it

2) Lionel JACQUES, University of Liège, Département d'aérospatiale et mécanique

email: ljacques@uliege.be

Miceli Carlotta

(Tutor: Dott.ssa Melania Del Santo, Cotutor: Dott. Julien Malzac)

Il collegio prende visione della relazione dell'allieva (**allegato 6 al verbale**).

L'allieva Miceli Carlotta ha svolto un dottorato in cotutela con l'Université de Toulose, pertanto, la proposta di composizione della commissione giudicatrice segue l'accordo di cotuela siglato fra le due Università

Membri effettivi

1) Prof. Marco Miceli, Università degli Studi di Palermo, marco.miceli@unipa.it

2) Prof. Ferreira Jonathan, University Grenoble Alpes, France

3) Prof.ssa Barbara De Marco, Universitat Politècnica de Catalunya, Spagna

4) Prof. Corbel Stephane, Université Paris Cité, France

5) Dott.ssa Melania Del Santo, INAF - Istituto di Astrofisica Spaziale e Fisica Cosmica, Palermo

6) Dott. Julien Malzac, CNRS/ Université de Toulouse, France

Membri supplenti

Dott.ssa Costanza Argiroffi, Università degli Studi di Palermo

Dott. Ciro Pinto, INAF - Istituto di Astrofisica Spaziale e Fisica Cosmica, Palermo

Il collegio nomina i valutatori esterni:

1) Barbara De Marco, Universitat Politècnica de Catalunya, Spagna

email: barbara.de.marco@upc.edu

2) Corbel Stephane, Université Paris Cité, France

email: stephane.corbel@u-paris.fr

2) Nomina dei Tutor/Cotutor per gli allievi titolari di borsa Marie Skłodowska-Curie Actions- Doctoral Networks

Il coordinatore comunica di aver ricevuto da parte della Prof. Umberto De Giovannini la richiesta di assegnare un tutor agli allievi titolari di borsa ***Marie Skłodowska-Curie Actions-Doctoral Networks.***

Subhojit PAL (39° ciclo)

Markos ARAPCHATZIS (41° ciclo)

Nola SEGALO (41° ciclo)

Il prof. De Giovannini espone il programma di ricerca per i tre allievi e alla fine della discussione viene proposta la seguente assegnazione tutor/cotutor e la seguente tematica di ricerca:

ALLIEVO	TUTOR/CO-TUTOR	TEMATICA
Subhojit PAL	U. De Giovannini (UNIPA)/ H. Hubener (Max Planck Institute)	*Dissipation in Time-Resolved Spectroscopies with TDDFT*
Markos ARAPCHATZIS	U. De Giovannini (UNIPA)	*Tr-ARPES of Light-Dressed Surface States*
Nola SEGALO	U. De Giovannini (UNIPA)	*Time-resolved spectroscopy with quantum light*

Il collegio approva all'unanimità

Il verbale è approvato seduta stante. La seduta si chiude alle ore 15:30.

Il Presidente
Prof. Marco Cannas

Il Segretario
Prof. Giuseppe Lazzara

Allegato 1

PHD IN PHYSICAL AND CHEMICAL SCIENCES, XXXVIII COURSE

PhD Candidate: MARIA ROSALIA CAROTENUTO

Transcript of Records

Tutor: Giuseppe Cavallaro (UNIPa) and Ileana Chinnici (INAF-OAPa)

Courses/school/exam scores:

- Project Management in the Scientific-Spatial Context, G. Micela, (INAF-OAPa) (20 hours)
- "Advanced microscopy and spectroscopy techniques applied to nanomaterials", S. Agnello e G. Buscarino, University of Palermo (20 hours)
- "Organic/Inorganic Nanocomposites: thermodynamics, structure, and applications", G. Cavallaro, University of Palermo (20 hours)
- Training Atomic Force Microscopy (AFM), February 17th, 2023 (online), G. Buscarino, ATeN Center, University of Palermo (4 hours)
- Summer School Course in "Metallography and microstructure of ancient and historic metals", prof. David Scott, August 21st – 25th 2023, Hastings (East Sussex, UK)
- International Spring School "Risk Management for Cultural Heritage. Challenges and Strategies for the GLAM Sector and UNESCO Sites", April 8th-12th 2024, University of Padova
- Lifelong Learning Course: "Cura, Conservazione e Catalogazione delle Strumentazioni Scientifiche Antiche (XIX-XX century), May 27th-31st 2024, organised by Centro Musei delle Scienze Naturali e Fisiche and the Department of Physics "Ettore Pancini", Naples

Research and training periods abroad
From 4. 11. 2024 to 29. 11. 2024 and from 25. 8. 2025 to 11. 9. 2025 at the Faculty of Chemistry and Chemical Technology (FKKT) of the University of Ljubljana (Slovenia).
Supervisor: prof. Matija Strlič

Publications:
Related to the PhD project

1) Carotenuto, M.R.; Cavallaro, G.; Chinnici, I.; Lazzara, G.; Milioto, S. **Thermo-mechanical properties of bionanocomposites based on polycaprolactone and halloysite clay nanotubes,** *J Therm Anal Calorim* 150, 7519–7528 **(2025).** https://doi.org/10.1007/s10973-025-14178-9

2) Carotenuto, M.R.; Cavallaro, G.; Chinnici, I.; Lazzara, G.; Milioto, S. **Hybrid Green Materials Obtained by PCL Melt Blending with Diatomaceous Earth.** *Molecules* **2024**, *29*, 1203. https://doi.org/10.3390/molecules29061203

3) Carotenuto, M.R.; Chinnici, I.; Camuffo D.; della Valle A.; Prestileo F.; Megna B.; Cavallaro, G.; Lazzara, G. **"An alert from Mars": Climate Risk Assessment and Conservation Challenges at the Specola Museum in Palermo,** *Heritage* **2024**, *7*, 7165-7187. https://doi.org/10.3390/heritage7120331

Not related to the PhD project

1) Carotenuto M.R., Sancataldo G., Agliolo Gallitto A., **Le sorgenti luminose artificiali della Collezione Storica degli Strumenti di Fisica dell'Università di Palermo**, *Museologia Scientifica*, 2024, *18. DOI: 10.53246/ANMS0043*
2) Agliolo Gallitto A., Carotenuto M.R., Termini G., Battaglia O.R., Fazio C., **Exploring rotations by a modified fidget spinner and a smartphone, 2025** *Phys. Educ.* 60, DOI: 10.1088/1361-6552/adba33
3) Agliolo Gallitto, A., Carotenuto, M.R., Termini, G., Battaglia, O.R., Fazio, C. **. The ballast metronome.** *Phys. Educ.***(2025)**, DOI: 10.1088/1361-6552/ae0d3d.
4) Carotenuto M.R., Chinnici I., Coniglio M., **I telescopi del Museo della Specola di Palermo: ieri, oggi e domani - The telescopes of the Museo della Specola in Palermo: past, present and future,** *Quaderni di storia della fisica" della Società Italiana di Fisica* **(2024).** DOI: 10.1393/edf/i2024-10571-4

Oral Communications

Related to the PhD project

1) XVIII International Clay Conference, July 13th - 18th 2025, Dublin, Ireland (online)
Carotenuto M.R., Cavallaro G., Lazzara G., Chinnici I., Milioto S., Exploring Polycaprolactone, Halloysite Nanotubes, Diatomaceous Earth, and their composites for Acetic Acid Mitigation in Museum Display Cases
2) XIII Congresso Nazionale AIAR, February 12th – 14th 2025, Palermo
Carotenuto M.R., Agliolo Gallitto A., Cavallaro G, Chinnici I, Lazzara G., What factors can affect lead corrosion processes in indoor museum environments? Case studies in historical collections at the University of Palermo
3) XLV National Conference on Calorimetry, Thermal Analysis and Applied Thermodynamics
December 9th-11th 2024, Caserta
Carotenuto M.R., Cavallaro G., Lazzara G., Chinnici I., Milioto S., Investigating the Influence of Halloysite Clay Nanotubes on the Thermo-mechanical Properties of Polycaprolactone.
4) XLIII Scientific Instrument Symposium, 18th-19th and 25th-26th November 2024, online.
Carotenuto M.R., Agliolo Gallitto A., Cavallaro G, Lazzara G., What leads to lead corrosion? A review of the causes and mechanisms in indoor museum environments. The talk is included in the session "Conservation of the scientific instruments"
5) XXVIII NATIONAL CONGRESS - SCI 2024, August 26th – 30th 2024, Milan
Carotenuto M.R., Cavallaro G., Lazzara G., Chinnici I., Milioto S., Green composites obtained by PCL melt blending with Diatomaceous Earth
6) XLII Scientific Instrument Symposium - Through Ages, Cultures, Concepts: Instruments in Collections, Books, Archives, September 18th-22nd 2023, Palermo. Carotenuto M.R., Lazzara G., Cavallaro G., Megna B., Camuffo D., della Valle A., Prestileo F., WARNING FROM MARS". Climate risk assessment in the Museo della Specola.

Not related to the PhD project

1) 111° Congresso Nazionale SIF, September 22nd-26th 2025, Palermo
F. Mirabello, M.R. Carotenuto, A. Agliolo Gallitto, I. Chinnici, Il Cerchio Ramsden: storia di un capolavoro della tecnica
2) Seminar "Libri e Astronomia: la Biblioteca dell'Osservatorio Astronomico di Palermo tra passato, presente e futuro" organized by INAF Astronomical Observatory of Palermo, on the occasion of the public event "Il maggio dei libri", May 30th 2023, Palermo

Carotenuto M.R., Strategie di conservazione del patrimonio scientifico
3)Workshop MAB INAF 2023, 29th – 31st March 2023, Florence
Carotenuto M.R., Attivita' e progetti presso il Museo della Specola

Posters:
1)Dat@MI - Convegno Tematico AIAr 2024, February 7th-9th 2024, Milan
Carotenuto M.R., Lazzara G., Cavallaro G., Megna B., Camuffo D., della Valle A., Prestileo F., Chinnici I., "A WARNING FROM MARS". Effect of microclimate changes at the Specola Museum of Palermo
2) XX Congresso della Divisione di Chimica dell'Ambiente e dei Beni Culturali, September 28th - October 1st 2023, Ischia
Carotenuto M.R., Cavallaro G., Milioto S., Lazzara G., Thermal and mechanical properties of polycaprolactone-based composites with diatomaceous earth and halloysite nanotubes
3) XLII Scientific Instrument Symposium - Through Ages, Cultures, Concepts: Instruments in Collections, Books, Archives, September 18th-22nd 2023, Palermo
Carotenuto M.R., Mirabello F., Agliolo Gallitto A., The "Impossible" Circle

Attendance to other conferences/workshops:
1) September 27th 2024. Attendance of "Historic Vehicles: "Disciplined" Conservation between Science and Culture" Conference, Museum of Engines and Mechanisms (Palermo), organised by the Italian Group of the International Institute for Conservation (IIC)
2) June 13rd 2024. Attendance of the Spring Conference "Museum Systems - State of the Art and Future Perspectives," 13 June 2024, G.G. Gemmellaro Museum (Palermo) organised by the University of Palermo's Museum System.
3) October 25th, 2023. Attendance at the conference "Novel physical and chemical methodologies for the conservation and restoration of Cultural Heritage - Italian scientific excellence in the museums of the world", organized by Accademia dei XL, Rome

CONFERENCE ORGANIZATION
1) Chair of the Scientific Organizing Committee and of the Local Organizing Committee for the International Workshop, TIMEKEEPERS IN HISTORICAL OBSERVATORIES. PALERMO, March 25th- 27th 2025
2) Co-organiser of the "*Conservation of the scientific instruments*" session at the XLIII Scientific Instrument Symposium, 18th-19th and 25th-26th November 2024, online.
3) Chair of the Local Organizing Committee, co-editor of the book of abstracts and Co-organizer of the session "Open Challenges in the Conservation of Scientific Instruments" of the XLII Scientific Instrument Symposium, September 18th-22nd 2023, Palermo

Thesis title:
Exploring Polycaprolactone, Halloysite nanotubes, Diatomaceous earth, and their composites for Acetic Acid Mitigation in museum enclosures

Abstract:

The long-term preservation of scientific and technological heritage is increasingly threatened by volatile organic compounds (VOCs), particularly low-molecular-weight carboxylic acids such as acetic and formic acids, which accumulate in poorly ventilated museum enclosures and trigger irreversible chemical degradation. Mitigating these pollutants is therefore essential for ensuring the long-term stability of sensitive collections. Nevertheless, the development of reliable, sustainable, and chemically safe adsorbents suitable for deployment in museum environments is still an open challenge, together with the absence of reproducible assessment protocols tailored to museum contexts.

This research work addresses these critical gaps by investigating Halloysite nanotubes (HNTs) and Diatomaceous earth (Diat) as green sorbents for reducing gaseous pollutants in museum enclosures, with particular focus on acetic acid. Because of its powdery nature, blends of the biodegradable polymer Polycaprolactone (PCL) were prepared to ensure safety for use in museum contexts. Although these naturally occurring materials have attracted growing interest as sustainable sorbents due to their high surface area, chemical stability, and versatile adsorption properties, their capacity to capture gas-phase carboxylic acids remains largely unexplored.

A comprehensive physico-chemical characterisation demonstrated that blending PCL with Diat or HNT is an effective strategy for obtaining biocompatible composites with enhanced viscoelastic, structural, and thermal properties compared with the pure polymer.

Their adsorption performance and chemical safety in museum environments were then assessed through a structured evaluation procedure developed during the research period at the Faculty of Chemistry and Chemical Technology (FKKT) of the University of Ljubljana (Slovenia). Within this framework, a systematic quantification of acetic acid uptake and formic/acetic acid release from raw materials and composites, together with assessments of pollutant retention and potential impacts on common heritage materials under museum-relevant conditions, was conducted for the first time.

The most effective materials were finally validated through an *in situ* deployment in an 18th-century historical display case at the Museo della Specola (Palermo). This transition from laboratory settings to a real museum environment represents one of the first practical tests in Italy of newly developed adsorbent materials for mitigating acetic acid in historical enclosures within a scientific collection of astronomical interest.

The research further extended to case studies within the Physics and Chemistry collections of the University of Palermo, where visible deterioration in lead-containing components of historical scientific instruments was consistent with corrosion induced by volatile organic acids accumulated in historical wooden enclosures. These investigations provided additional evidence of the broader relevance of VOC-driven degradation in scientific heritage contexts, particularly where original exhibition enclosures remain in use and cannot be replaced.

Overall, the results provided an assessment of HNTs, Diat, and their PCL-based hybrids as gas-phase sorbents for carboxylic acids under heritage-relevant conditions and contributed to the standardisation of protocols for the development and comparative assessment of new sustainable sorbents in preventive conservation.

The PhD Board Dean

Prof. Marco Cannas

Marco Cannas

Allegato 2

PHD IN PHYSICAL AND CHEMICAL SCIENCES, XXXVIII COURSE

PhD Candidate: Chiara Ferlito

Transcript of Records

Tutor: Prof. Giuseppe Lazzara

Cotutor: Dott. Marco Bertini

Courses/school/exam scores:

- Advanced microscopy and spectroscopy techniques applied to nanomaterials; Prof. Gianpiero Buscarino, Prof. Simonpietro Agnello. (Via archirafi 36, Palermo)
- Organic/Inorganic Nanocomposites: thermodynamics, structure, and applications; Dott. Giuseppe Cavallaro (Ed 17, Palermo)
- Density Functional Theory (DFT) and Time-Dependent Density Functional Theory (TDDFT). Dott. Umberto De Giovannini (Ed 17, Palermo)

- Soft Matter Summer School 2025 - July 1-3, 2025- Institut Max von Laue - Paul Langevin (ILL), Grenoble
- School of Physical Chemistry 2023 - Frontiers in Materials Physical Chemistry: Nanostructures and Nanomaterials (Verbania – June 19-23,2023)
- Seminar: "Physics of Membranes and Active Systems", Amphithéâtre Henri Benoît Istituto Charles Sadron, CNRS Strasburgo.
- Safety training meeting - Friday 16 October 2024 - Institut Charles Sadron, Strasburgo
- Training Zetasizer Malvern - Mesure de tailles (1 à 1000 nm) – 13 December 2024 - Legros Mélanie, Institut Charles Sadron, Strasburgo
- Training Zetasizer Malvern - Mesure de potentiel zeta – 30 Genuary 2025 Legros Mélanie, Institut Charles Sadron, Strasburgo
- Seminar: "Attosecond pulses of light for studying electron dynamics by Anne L'Huillier" – 12 March 2025 – Amphitheatre Guy Ourisson – Faculte de Chemie Strasbourg
- Chimica Teorica e Computazionale; Prof. Francesco Ferrante (Ed 17, Palermo)
- "Training SEM"; Giorgio Nasillo, Vincenzo La Carrubba (ATeN Center, Ed 18/A, May 10th 2023).
- "Smart-X Workshop on X-spectroscopy and related phenomena". (Orto Botanico, Palermo, December 4-6
- "Normal Dynamics: solving Newton's equations of motion in the reciprocal space" Prof. Antonio Cammarata, February 19th, 2024 (Ed 17, Viale delle Scienze, Palermo).
- "Towards a universal framework to describe and control atom-scale friction" Prof. Antonio Cammarata, February 20th, 2024 (Ed 17, Viale delle Scienze, Palermo)

Research and training periods abroad

- Research period carried out at the Institut Charles Sadron (CNRS), University of Strasbourg, France (October 2024 – April 2025). The activity focused on investigating the interaction between giant vesicles and halloysite nanotubes (HNTs), with particular emphasis on optical and fluorescence microscopy and the design of biomimetic systems.

Papers published:

- Ferlito, C.; Rizzo, C.; Merir, R.; Cavallaro, G.; Lisuzzo, L.; Piccionello, A. P.; Lazzara, G. *Influence of Halloysite Nanotubes from Different Deposits on the Degradation of Organic Molecules. Ceramics International* 2025, S0272884225010995. https://doi.org/10.1016/j.ceramint.2025.02.403
- Guercio, L.; Ferrante, F.; Bertini, M.; Ferlito, C.; Lisuzzo, L.; Lazzara, G.; Duca, D. *Anchoring Gold Nanoparticles on Functionalized Halloysite Nanotubes: Density Functional Theory and Experimental Studies. J. Phys. Chem. C* 2025, 129(37), 16944–16957. https://doi.org/10.1021/acs.jpcc.5c05165
- Ferrante, F.; Bertini, M.; Ferlito, C.; Lisuzzo, L.; Lazzara, G.; Duca, D. *A Computational and Experimental Investigation of Halloysite Silicic Surface Modifications after Alkaline Treatment. Applied Clay Science* 2023, 232, 106813. https://doi.org/10.1016/j.clay.2022.106813
- Lisuzzo, L.; Bertini, M.; Lazzara, G.; Ferlito, C.; Ferrante, F.; Duca, D. *A Computational and Experimental Investigation of the Anchoring of Organosilanes on the Halloysite Silicic Surface. Applied Clay Science* 2023, 245, 107121. https://doi.org/10.1016/j.clay.2023.107121

Conferences/workshop attended:

- Talks:

  • Ferlito, C.; Lisuzzo, L.; Cavallaro, G.; Lazzara, G.; Schmutz, M.; Stocco, A. *Halloysite Nanotubes Interacting with Lipid Vesicle Membranes*. Oral Presentation, 37th Conference of the European Colloid and Interface Society (ECIS), Bristol (UK), 2025.

  • Ferlito, C.; Lisuzzo, L.; Cavallaro, G.; Lazzara, G.; Schmutz, M.; Stocco, A. *Exploring the Interactions of Halloysite Nanotubes with GUVs as Biomembrane Models*. Oral Presentation, NANONEURO – Controlled Delivery of Therapeutic Oligonucleotides by Inorganic Nanomaterials for the Treatment of Rare Neurodegenerative Diseases, Palermo (Italy), 25–26 September 2025.

  • Ferlito, C.; Lisuzzo, L.; Guercio, L.; Cavallaro, G.; Lazzara, G. *Thermal Analysis of Hematite–Wax Pickering Emulsions for Environmental Applications*. Oral Presentation, Conference on Colloids and Interface Science, Thessaloniki (Greece), 9 July 2025.

• Ferlito, C.; Rizzo, C.; Merir, R.; Cavallaro, G.; Lisuzzo, L.; Palumbo Piccionello, A.; Lazzara, G. *Influence of Halloysite from Different Deposits on Organic Molecules Degradation.* Oral Presentation, European Student Colloid Conference, Bordeaux (France), 24–27 June 2024.

• Ferlito, C.; Rizzo, C.; Merir, R.; Cavallaro, G.; Lisuzzo, L.; Palumbo Piccionello, A.; Lazzara, G. *Influence of Halloysite from Different Deposits on Organic Molecules Degradation.* Oral Presentation, 61st Annual Meeting of The Clay Minerals Society & 5th Asian Clay Conference, University of Hawaii at Mānoa (USA), 2024.

• Ferlito, C.; Rizzo, C.; Merir, R.; Cavallaro, G.; Lisuzzo, L.; Palumbo Piccionello, A.; Lazzara, G. *Influence of Halloysite on the Degradation of Ibuprofen and Ascorbic Acid.* Oral Presentation, XXVIII Congresso Nazionale della Società Chimica Italiana (SCI), Milan (Italy), 26–30 August 2024.

- Posters:

• Ferlito, C.; Ferrante, F.; Bertini, M.; Lisuzzo, L.; Lazzara, G.; Duca, D. *A Computational and Experimental Investigation of the HNT Silicic Surface.* Poster Presentation, 37th Conference of the European Colloid and Interface Society (ECIS), Naples (Italy), 3–8 September 2023.

• Ferlito, C.; Ferrante, F.; Bertini, Lisuzzo, L; A.; Lazzara, G.Duca, D *A Computational and Experimental Investigation of the Modified Halloysite Silicic Surface.* School of Physical Chemistry 2023 - Frontiers in Materials Physical Chemistry: Nanostructures and Nanomaterials (Verbania – June 19-23,2023)

Thesis title: Multifunctional and sustainable nanomaterials for emergent pollutant removal

Abstract:

The increasing release of pollutants into the environment represents one of the major challenges of the 21st century. This work presents a multidisciplinary investigation of advanced nanomaterials for sustainable pollutant removal and environmental remediation, exploring halloysite nanotubes, hematite microparticles, and manganese oxide nanoparticles and their roles in adsorption, magnetic recovery, and photocatalysis. Experimental, computational, and biointeraction approaches are integrated to evaluate material performance in water pollutant removal, with a particular focus on the development and application of non-toxic and eco-friendly systems.

The PhD Board Dean

Prof. Marco Cannas

Allegato 3

PHD IN PHYSICAL AND CHEMICAL SCIENCES, XXXVIII COURSE

PhD Candidate: *Pietro Castronovo*

Transcript of Records

Tutor: *Prof. Fabrizio Messina*

Cotutor: *Dr. Alice Sciortino*

Courses/school/exam scores:

- *Advanced time resolved spectroscopy*, Prof. Marco Cannas and Prof. Fabrizio Messina, Grade A
- *Organic/Inorganic Nanocomposites: thermodynamics, structure, and applications*, Dr. Giuseppe Cavallaro, Grade A
- *Project Management in the Scientific-Spatial Context*, Dr. Giuseppina Micela, INAF Osservatorio Astronomico di Palermo, Grade A

Awards and recognitions

- Best Oral Presentation award - The 5th International Online Conference on Nanomaterials – September 2025
- Best Oral Presentation award - The 4th International Online Conference on Materials – November 2025

Research and training periods abroad

- 01/09/2023 – 18/11/2023: Research period abroad at the Van der Waals – Zeeman Institute of Physics, University of Amsterdam, Amsterdam, The Netherlands, supervisor: Prof. Dr. Peter Schall;
- 15/01/2024 – 15/04/2024: Research period abroad at the Hubert Curien Laboratory, Jean Monnet University, Saint-Etienne, France, supervisor: Dr. Vincenzo de Michele;
- 19-20/07/2025: Fully funded beamtime at the European Synchrotron Radiation Facility (ESRF), Grenoble (France).

Papers published:

1. **P. Castronovo**, M. Reale, S.A. Rigter, C.R. Kagan, C.B. Murray, S.Lorenzo, E.C. Garnett, P. Schall, E. Marino, A. Sciortino, F. Messina. *Ultrafast Switching of Whispering Gallery Modes in Quantum Dot Superparticles*, Nano Letters 2025, 25, 14, 5828-5835 - *Selected for main cover feature*
2. **P. Castronovo**, C. Gonzalez, G. Ammirati, S. Yang, D. Catone, A. Paladini, P. O'Keeffe, C.R. Kagan, C.B. Murray, A. Emanuele, E. Marino, F. Messina, A. Sciortino. *Interparticle Distance Controls Ultrafast Photodynamics in Crystalline Gold Superstructures*, Advanced Optical Materials 2025, 13, 30, e02501
3. M. Reale, **P. Castronovo**, M. Cannas, E. Marino, A. Sciortino, F. Messina. *Excitation-Wavelength-Tunable Lasing in Individual Quantum Dot Superparticles*, Advanced Optical Materials 2025, 13, 22, 2500838
4. L.G. Barbata, M. Mazaj, R. Ettlinger, G. Ficarra, **P. Castronovo**, A. Sciortino, F. Messina, R.E. Morris, G. Buscarino. *Luminescent sensing of Hg2+ ions using MOF-808 combined with Au25@ BSA nanoclusters*, Materials Research Bulletin 2025, 188, 113397

Papers submitted or in preparation:

1. N. Hosseiniyan, **P. Castronovo**, G. Beaune, E. Abdelrady, X. Chen, A. Zhyvolozhnyi, H. Jiang, M. Makki, M. Cannas, A. Sciortino, A. Samoylenko, J.V.I. Timonen, S. Vainio, F. Messina, S. Chandra. *Synergistic effects in matrix-embedded alloy nanoclusters: Advanced Type-I photosensitizers for theranostics*, Submitted (2025)
2. V. Liljeström* **P. Castronovo***, D. Agrawal, S. Das, N. Hosseiniyan, J. Seitsonen, H. Jiang, M. Cannas, A. Sciortino, Z. Sun, F. Messina, S. Chandra. *Controlled self-assembly of atomically precise ultrasmall Au6 nanoclusters into hierarchical fibrillar superstructures*, Submitted (2025) (*: co-first authors)
3. **P. Castronovo**, M. Reale, C.R. Kagan, C.B. Murray, E. Marino, A. Sciortino, F. Messina. *Collective Exciton Dynamics in Quantum Dot Superparticles*, In Preparation (2025)
4. **P. Castronovo**, R. Rubino, Y. Tang, P. Schall, E. Marino, F. Messina, A. Sciortino. *Perovskite Supercubes with Crystalline Ordering: Unveiling the Assembly Dynamics*, In Preparation (2025)

Conferences/workshop attended:

- Talks:
  - **P. Castronovo**, A. Sciortino, F. Messina. *There's plenty of room in the blink of an eye: ultrafast phenomena and their observation*, Italian Conference of Physics Students 2023 (CISF23), April 2023, Palermo (Italy)
  - **P. Castronovo**, M. Reale, Y. Tang, P. Schall, E. Marino, A. Sciortino, F. Messina. *Self-Assembly of Nanomaterials: a Pathway to the Tailoring of their Photophysical Properties*, German-Italian Physics Exchange 2023 (GIPE23), October 2023, Bari (Italy)
  - **P. Castronovo**, M. Reale, C.R. Kagan, C.B. Murray, E. Marino, A. Sciortino, F. Messina. *Ultrafast Photodynamics of Quantum Dot Superparticles Unraveled by Transient Absorption Microscopy*, E-MRS Spring Meeting 2024, May 2024, Strasbourg (France)
  - **P. Castronovo**, M. Reale, C.R. Kagan, C.B. Murray, E. Marino, A. Sciortino, F. Messina, *Pump-Probe Microscopy Unravels the Ultrafast Photodynamics of Quantum Dot Superparticles for Future Applications in Micro-Photonics*, **Invited** Talk, MetaFUN 2024, July 2024, Palermo (Italy)
  - **P. Castronovo**, Y. Tang, V. De Michele, P. Schall, A. Boukenter, M. Cannas, A. Sciortino, F. Messina. *Enabling Collective Behaviour of Metal Halide Perovskite Nanocubes via Hierarchical Assembly into Superstructures*, 13th Young Researcher Meeting, September 2024, Palermo (Italy)
  - **P. Castronovo**, G. Ammirati, C. Gonzales, S. Yang, D. Catone, A. Paladini, P. O'Keeffe, C.B. Murray, E. Marino, F. Messina, A. Sciortino. *Unraveling the collective plasmonic behaviour of gold nanocrystal superparticles via ultrafast pump-probe microscopy*, 8th International Conference on Multifunctional, Hybrid and Nanomaterials, March 2025, Montpellier (France)
  - **P. Castronovo**, G. Ammirati, C. Gonzales, S. Yang, D. Catone, A. Paladini, P. O'Keeffe, C.B. Murray, E. Marino, F. Messina, A. Sciortino, *Interparticle distance controls the collective plasmonic behaviour of gold nanocrystal superparticles*, 5th International Online conference on Nanomaterials, September 2025
  - **P. Castronovo**, C. Gonzales, G. Ammirati, S. Yang, D. Catone, A. Paladini, P. O'Keeffe, C.R. Kagan, C. B. Murray, A. Emanuele, E. Marino, F. Messina, A. Sciortino, *Pump-Probe Microscopy Unravels Distance- Dependent Collective Plasmonic Behaviour in Gold Nanoparticle Supercrystals*, 4th International Online Conference on Materials, November 2025.

- Posters:
  - P. Castronovo, M. Reale, E. Marino, A. Sciortino, F. Messina. Ultrafast Transient Absorption Microscopy on Semiconductor Quantum Dot Supercrystals, MECAREACT23 School, June 2023, Paris (France)
  - P. Castronovo, C. Gonzales, G. Ammirati, S. Yang, D. Catone, A. Paladini, P. O'Keeffe, C.R. Kagan, C. B. Murray, A. Emanuele, E. Marino, F. Messina, A. Sciortino, Interparticle Distance Controls Ultrafast Photodynamics in Crystalline Gold Superstructures, AFuN25, September 2025, Palermo (Italy)

Thesis title: ***Photophysics and Photonics of Self-Assembled Superstructures***

Abstract:
Nanomaterials represent a cornerstone of modern materials science, as their diverse properties enable functionalities unattainable in bulk form. In recent years, assembling nanoparticles into mesoscopic structures has emerged as a powerful route to unlock an even wider range of collective and emergent behaviours. When nanocrystals are brought into close proximity, their interactions reshape the electronic and optical responses in ways that transcend those of isolated particles.
Progress in colloidal synthesis, purification, and assembly now enables near monodisperse nanoparticles to be organised into three dimensional superstructures with crystalline, quasi crystalline, or amorphous symmetry, often referred to as superparticles. Virtually any colloidal nanoparticle can serve as a building block for these artificial solids, including chalcogenide and perovskite quantum dots or nanorods, plasmonic nanoparticles, magnetite nanocrystals, and ultrasmall noble metal nanoclusters. Their assemblies display a plethora of intriguing behaviours including exciton delocalisation and band like transport, collective plasmonic resonances, ultra efficient surface enhanced Raman scattering, superfluorescence, long range charge or energy migration, and coupled photonic or excitonic modes, as well as aggregation induced photoluminescence. While the mechanisms underpinning self assembly and the technological promise of these materials have both been intensely studied, the systematic connection between structure and collective response remains far from fully established. Addressing these open questions requires approaches that combine high spatial and temporal resolution, capable of isolating the behaviour of individual superstructures while tracking interparticle cross-talk effects that evolve on sub nanosecond timescales.

Within this framework, the aim of this thesis is to elucidate the photophysics and photonics of three-dimensional superstructures assembled from different classes of semiconductor- and metal-based nanosystems. To this end, we combine diverse assembly strategies with structural characterisation, first-principles simulations, and spectroscopic techniques spanning different spatial and temporal scales. Leveraging a broad palette of building blocks enables us to probe a correspondingly broad range of collective behaviours, while the synergy between complementary experimental approaches provides a more complete understanding of their responses. Among the characterisation techniques we employ, a prominent role is played by ultrafast transient absorption microscopy, which combines high spatial and temporal resolution thereby allowing to unravel the photoinitiated dynamics of single superstructures at the sub-nanosecond timescales. The results presented in this thesis advance the fundamental understanding of the collective behaviour of artificial solids, thereby informing future efforts to rationally design self-assembled materials with tailored functionalities.

The PhD Board Dean

Prof. Marco Cannas
Marco Cannas

Allegato 4

PHD IN PHYSICAL AND CHEMICAL SCIENCES, XXXVIII COURSE

PhD Candidate: Simone Virga

Transcript of Records

Tutor: Prof. Francesco Giannici
Cotutor: Dr. Alessandro Longo

Courses/school/exam scores:

- "Advanced microscopy and spectroscopy techniques applied to nanomaterials" – course taken at the University of Palermo passed with A grade on 28/10/24.
- "Organic/Inorganic Nanocomposites: thermodynamics, structure, and applications" – course taken at the University of Palermo passed with A grade on 17/06/25.
- "Advanced time resolved spectroscopy" – course taken at the University of Palermo passed with A grade on 21/10/25.
- "Advanced materials and technologies for photovoltaics" – course taken at the University of Palermo not included among the courses of the 38th cycle.

Research and training periods abroad

- Partecipation in the MA-5455 experiment at ESRF in Grenoble (France), beamline BM08, carried out from 26/01/23 to 30/01/23.
- Partecipation in the MA-5465 experiment at ESRF in Grenoble, beamline BM08, carried out from 28/09/23 to 02/10/23.

- Co-proposer of the CH-6842 experiment at ESRF in Grenoble, beamline ID20, carried out from 07/11/23 to 13/11/23.
- Co-proposer of the CH-7120 experiment at ESRF in Grenoble, beamline ID22, carried out from 23/10/24 to 28/10/24, and beamline ID26, carried out from 19/11/24 to 21/11/24.
- Co-proposer of the 20240114 experiment at SOLEIL in Saint-Aubin (France), beamline SAMBA, carried out from 27/11/24 to 29/11/24, and beamline CRISTAL, carried out from 29/11/24 to 02/12/24.
- Co-proposer of the CH-7812 experiment at ESRF in Grenoble, beamline ID26, carried out from 25/11-01/12/25.
- Research internship from 01/02/24 to 31/07/24 in the group of Prof. Jochen Feldmann at the Physics Faculty of the Ludwig-Maximilians University in Munich, Germany.
- Training course for Transmission Electron Microscopy (TEM) carried out at LMU, Munich, Germany, from 04/03/24 to 08/03/24.

Papers published:

1. Virga, S.; Macias-Pinilla, D.F.; Dengo, N.; Bini, S.; Giannici, F.; Bertolotti, F. Bonding Mechanisms Underpinning Structural and Electronic Properties of Halide Perovskites. *Coordination Chemistry Reviews* 2025, in press.
2. Virga, S.; Macias-Pinilla, D.F.; Dengo, N.; Bertolotti, F.; Longo, A.; He, F.; Akkerman, Q.A.; Giannici, F. Cu-doped $Cs_3Sb_2Cl_9$ nanocrystals: revisiting the low bandgap of $Cs_2CuSbCl_6$ double perovskites. *ACS Materials Lett.* 2025, 7, 3623-3633. https://doi.org/10.1021/acsmaterialslett.5c01043.
3. Dengo, N.; Macias-Pinilla, D.F.; Anzini, P.; Colombo, M.; Virga, S.; Brambilla, A.; Zecca, P.A.; Monticelli, D.; Giannici, F.; Bertolotti, F. Atomistic Insights into Halide Double Perovskite Nanocrystals obtained by Multistep Synthesis and Efficient Compositional Engineering. *ACS Nano* 2025, 19, 30151-30164. https://doi.org/10.1021/acsnano.5c06497.
4. Virga, S.; Arrabito, G.; Ferrara, V.; Scopelliti, M.; Longo, A.; Pignataro, B.; Giannici, F. Bismuth Drives the Morphology and Piezoresistivity of Lead-free $(TMSO)_3Sn_{3-x}Bi_{2(1-x)}I_9$ Halide Perovskite thin films. *J. Mater. Chem. C* 2024, 12, 12951-12961. https://doi.org/10.1039/D4TC01777C.

5. Virga, S.; Longo, A.; Pipitone, C.; Giannici, F. Structural Features Governing the Near-Edge X-ray Absorption Spectra of Lead Halide Perovskites. *J. Phys. Chem. C* 2023, 127, 18058-18066. https://doi.org/10.1021/acs.jpcc.3c03604.
6. Ursi, F.; Virga, S.; Pipitone, C.; Sanson A.; Longo, A.; Giannici, F.; Martorana, A. Modelling the structural disorder in trigonal prismatic coordinated transition metal dichalcogenides. *J. Appl. Cryst.* 2023, 56, 502-509. https://doi.org/10.3390/ma15238297.
7. Ursi, F.; Virga, S.; Garcia-Espejo, G.; Masciocchi, N.; Martorana, A.; Giannici, F. Longo, A. Term Stability of TiS_2–Alkylamine Hybrid Materials. *Materials* 2022, 15, 8297. https://doi.org/10.3390/ma15238297.

Conferences/workshop attended:

- Posters:
- "Structural Properties Determining the Near-Edge X-Ray Absorption Spectra of Lead Halide Perovskites" presented at the "49° Congresso Nazionale di Chimica Inorganica" (INORG2023), held in Perugia from 12/09/232 to 15/09/23.
- "Morphology and Piezoresistivity of Lead-Free $(TMSO)_3Sn_{\alpha}Bi_{2(1-\alpha)}I_9$ Halide perovskite Thin Films Influenced by Bismuth" presented at the "7th International Conference on Perovskite Solar Cells and optoelectronics" (PSCO 2024), held in Perugia from 16/09/24 to 18/09/24.

Thesis title: Atomic and Electronic Structure of Lead-Free Halide Perovskites Probed with X-ray Absorption Spectroscopy.

Abstract:
Lead-based halide perovskites, and in particular hybrid organic–inorganic systems such as MAPI, have attracted significant attention in recent decades due to their promising optoelectronic properties. However, the poor air stability of hybrid perovskites and the high toxicity of lead hinder their large-scale implementation. In this work, I explore different ways to overcome these limitations, beginning with the replacement of the organic cation to enhance the stability of lead-based perovskites, and subsequently addressing the substitution of the toxic metal cation through either an isovalent

approach, with Sn(II), or a heterovalent approach, with monovalent and trivalent cations to obtain double perovskites. After laboratory characterization, all the bulk and nanosized materials were studied with synchrotron radiation methods, especially X-ray absorption spectroscopy (XAS). XAS is an ideal complement to diffraction methods for probing the local structure of materials: nevertheless, despite its potential and the ever-growing body of literature on halide perovskites, the application of XAS to these compounds has so far remained relatively limited and with varying degrees of success. Both the near-edge and the extended regions of the XAS spectra were modeled quantitatively, providing information on oxidation state and local symmetry bond length and disorder. These spectra were complemented by HERFD also in the tender X-ray range, which enhances the energy resolution and reveals subtle features not accessible through conventional XAS. The experimental data were eventually modeled with ab initio simulations, allowing for the refinement of the local structural model and leading to accurate assessment of distortions and structural variations induced by cation substitution.

The PhD Board Dean

Prof. Marco Cannas

Marco Cannas

Allegato 5

PHD IN PHYSICAL AND CHEMICAL SCIENCES, XXXVIII COURSE

PhD Candidate: Edoardo Alaimo

Transcript of Records

Tutor: Prof. Fabio Reale

Cotutor: Prof. Marco Barbera

Courses/school/exam scores:

- **Advanced microscopy and spectroscopy techniques applied to nanomaterials**
  (Ref. 1) S. Agnello – simonpietro.agnello@unipa.it;
  (Ref. 2) G. Buscarino – gianpiero.buscarino@unipa.it
- **Project Management in the Scientific-Spatial Context**
  (Ref.) G. Micela – giusi.micela@inaf.it
- **Astrophysics laboratory of thermal X-ray plasmas**
  (Ref.) C. Pinto – ciro.pinto@inaf.it

Research and training periods abroad

- **04/11/2023 – 01/02/2024 (3 months) – Visiting PhD Student at the Lockheed Martin Solar and Astrophysics Laboratory, Palo Alto, California, USA – Tutor: Dr. Paola Testa**

Papers published

As 1st author:

1. *Authors*: Edoardo Alaimo, Michela Todaro, Luisa Sciortino, Ugo Lo Cicero, Federico Fiorentino, Fabio D'Anca, Salvatore Varisco, Roberto Candia, Gaspare Di Cicca, Fabio Reale, Paolo Pagano, Costanza Argiroffi, Antonino Petralia, Paola Testa, Gabriele Cozzo, Peter N. Cheimets, Paul Boerner, Bart W. De Pontieu, Vincentz Knagenhjelm, Pekka T. Törmä, Mika Moisanen, Bjørn Mikladal, Bahawal Haq, Benjamin R. Zeiger, Pascal Mercère, Paulo Da Silva, Daniele Brienza, Denise Perrone, Marco Stangalini, Marco Barbera,
   Title: Optical blocking filters for the Multi-slit Solar Explorer mission: in-band extreme ultraviolet and soft X-ray transmittance spectroscopy measurements and analysis
   J. Astron. Telesc. Instrum. Syst. 11(4) 048001 (2025), DOI: 10.1117/1.JATIS.11.4.048001
2. *Authors:* Edoardo Alaimo, Daniele Spiga, Adrian Daw, Fabio Reale, Bart De Pontieu, Paul Boerner, Paola Testa, Ugo Lo Cicero, Michela Todaro, Luisa Sciortino, Fabio D'Anca, Gabriele Cozzo, Federico Fiorentino, Costanza Argiroffi, Paolo Pagano, Pekka T. Törmä, Ilkka Varjos, Mika Moisanen, Bjorn Mikladal, Jarkko Etula, Daniele Brienza, Denise Perrone, Marco Stangalini, Marco Barbera
   Title: Investigation on the role of optical filters on the point spread function of the NASA MIDEX solar mission MUSE
   Proc. SPIE 13699, International Conference on Space Optics — ICSO 2024, 136995J (28 July 2025); DOI: 10.1117/12.3075223

As co-author:

1. *Authors:* G. Cozzo, J. Reid, P. Pagano, F. Reale, P. Testa, A. W. Hood, C. Argiroffi, A. Petralia, E. Alaimo, F. D'Anca, L. Sciortino, M. Todaro, U. Lo Cicero, M. Barbera, B. De Pontieu, J. Martinez-Sykora
   Title: Coronal energy release by MHD avalanches - II. EUV line emission from a multi-threaded coronal loop
   A&A, 689 (2024) A184, DOI: 10.1051/0004-6361/202450644

2. *Authors:* Michela Todaro, Luisa Sciortino, Ugo Lo Cicero, Edoardo Alaimo, Federico Fiorentino, Fabio D'Anca, Salvatore Varisco, Roberto Candia, Gaspare Di Cicca, Alfonso Collura, Michael Krumrey, Christian Laubis, Michael Kolbe, Nelson De Oliveira, Laurent Nahon, Philippe Laurent, Philippe Ferrando, Marco Barbera
   Title: Wide-band transmission response of the filters for the X-IFU detector of the Athena Observatory
   Proc. SPIE 13699, International Conference on Space Optics — ICSO 2024, 1369910 (28 July 2025); DOI: 10.1117/12.3075217
3. *Authors:* Fabio D'Anca, Edoardo Alaimo, Michela Todaro, Luisa Sciortino, Ugo Lo Cicero, Federico Fiorentino, Nicola Montinaro, Salvatore Varisco, Roberto Candia, Gaspare Di Cicca, Maurizio Filizzolo, Alberto Costantini, Antonio Alvino, Fabio Reale, Costanza Argiroffi, Gabriele Cozzo, Paolo Pagano, Pekka T. Törmä, Jari Kostamo, Ilkka Varjos, Mika Moisanen, Bjorn Mikladal, Jarkko Etula, Paul Boerner, Vincentz Knagenhjelm, Peter Cheimets, Edward Hertz, Daniele Brienza, Denise Perrone, Marco Stangalini, Marco Barbera
   Title: Mechanical qualification of metal-coated-carbon-nanotube optical blocking filters developed for the NASA MIDEX solar mission MUSE
   Proc. SPIE 13699, International Conference on Space Optics — ICSO 2024, 136995M (28 July 2025); DOI: 10.1117/12.3075220
4. *Authors:* Federico Fiorentino, Edoardo Alaimo, Luisa Sciortino, Michela Todaro, Ugo Lo Cicero, Fabio D'Anca, Nicola Montinaro, Salvo Varisco, Roberto Candia, Gaspare Di Cicca, Pekka T. Törmä, Jari Kostamo, Ilkka Varjos, Mika Moisanen, Bjorn Mikladal, Marco Barbera
   Title: Multitechnique characterization of bare and metal-coated carbon nanotube ultrathin pellicles
   Proc. SPIE 13699, International Conference on Space Optics — ICSO 2024, 136995O (28 July 2025); DOI: 10.1117/12.3075222
5. *Authors:* Luisa Sciortino, Fabio D'Anca, Federico Fiorentino, Michela Todaro, Edoardo Alaimo, Ugo Lo Cicero, Enrico Bozzo, Gaspare Di Cicca, Roberto Candia, Salvatore Varisco, Marco Barbera
   Title: Effect of particle contamination on the WFI filters of the Athena mission in a launch vibration environment
   Proc. SPIE 13699, International Conference on Space Optics — ICSO 2024, 136996R (28 July 2025); DOI: 10.1117/12.3075418
6. *Authors:* Luisa Sciortino, Michela Todaro, Edoardo Alaimo, Federico Fiorentino, Fabio D'Anca, Ugo Lo Cicero, Elena Magnano, Igor Pís, Silvia Nappini, Federica Bondino, Pekka T. Törmä, Jari Konstamo, Bjorn Mikladal, Mika Moisanen, Ilkka Varjos, Salvatore Varisco, Roberto Candia, Gaspare Di Cicca, Marco Barbera
   Title: Oxidation of aluminum coating on ultrathin films of carbon nanotubes as filters for high-energy astrophysics space missions
   Proc. SPIE 13699, International Conference on Space Optics — ICSO 2024, 136996B (28 July 2025); DOI: 10.1117/12.3075218
7. *Authors:* Marco Barbera, Fabio D'Anca, Michela Todaro, Luisa Sciortino, Ugo Lo Cicero, Edoardo Alaimo, Federico Fiorentino, Salvatore Varisco, Roberto Candia, Gaspare Di Cicca, Nicola Montinaro, Fabio Reale, Costanza Argiroffi, Gabriele Cozzo, Paolo Pagano, Daniele Spiga, Daniele Brienza, Denise Perrone, Marco Stangalini, Pekka T. Törmä, Jari Kostamo, Ilkka Varjos, Mika Moisanen, Bjorn Mikladal, Paul Boerner, Bart De Pontieu, Vincentz Knagenhjelm, Peter Cheimets, Edward Hertz, Paola Testa
   Title: Metal-coated carbon nanotube ultrathin pellicles: a high-performance solution for the optical blocking filters of the NASA MIDEX solar mission MUSE
   Proc. SPIE 13699, International Conference on Space Optics — ICSO 2024, 136991P (28 July 2025); DOI: 10.1117/12.3075219

Papers accepted/submitted/in preparation

1. *Authors:* G. Cozzo, P. Testa, J. Martinez-Sykora, F. Reale, P. Pagano, F. Rappazzo, V. Hansteen, B. De Pontieu, A. Petralia, E. Alaimo, F. Fiorentino, F. D'Anca, L. Sciortino, M. Todaro, U. Lo Cicero, M. Barbera
   Title: 3D MHD simulations of coronal loops heated via magnetic braiding - I. Continuous driving
   Accepted for publication in A&A.
2. *Authors:* E. Alaimo, B. Mikladal, M. Todaro, L. Sciortino, U. Lo Cicero, F. Fiorentino, F. D'Anca, F. Reale, M. Moisanen, B. Haq, P. Törmä, M. Barbera
   Title: Comparative Experimental Study of Single- and Multi-walled Carbon Nanotube Pellicles for Space Instrumentation and EUV Lithography.
   Submitted.
3. *Authors:* F. Fiorentino, U. Lo Cicero, E. Alaimo, L. Sciortino, M. Todaro, F. D'Anca, S. Varisco, R. Candia, G. Di Cicca, P. Törmä, H. Lipsanen, B. Mikladal, B. Haq, M. Barbera
   Title (Tentative): Zirconium-coated Carbon nanotube pellicles for high-energy optical filter applications.
   In preparation.

Technical reports published

1. *Authors:* Pekka Törmä, Ikka Varjios, Marco Barbera, Fabio D'Anca, Ugo Lo Cicero, Luisa Sciortino, Michela Todaro, Nicola Montinaro, Alaimo Edoardo
   Title: Final report - Corresponding Task 6: Conclusions and programmatic
   LAOF-CCN-FR-1 Final Report, HANDLE: 20.500.12386/34469
2. *Authors:* Pekka Törmä, Marco Barbera, Fabio D'Anca, Ugo Lo Cicero, Luisa Sciortino, Michela Todaro, Nicola Montinaro, Alaimo Edoardo
   Title: Technical Note 9 – Athena filters: conclusion and programmatic
   LAOF-CCN-TN-09 Technical Note, HANDLE: 20.500.12386/34468
3. *Authors:* Marco Barbera, Fabio D'Anca, Ugo Lo Cicero, Luisa Sciortino, Michela Todaro, Nicola Montinaro, Alaimo Edoardo, Pekka Törmä
   Title: TN8 – Athena filters characterization and qualification report
   LOAF-CCN-TN-08 Technical Note, HANDLE: 20.500.12386/34467

Conferences/workshop attended, seminars, experimental campaigns:

<u>Talks</u>

1. *Title:* Advancements in Carbon Nanotube-Based Filters for EUV Solar Coronal Spectroscopy.
   Scientific talk given at the SoHe 2023- Fourth Meeting of the Italian Solar and Heliospheric Community, INAF Osservatorio Astronomico di Arcetri, Florence, Italy (25-27 Oct 2023). **Best Oral Presentation (Lucio Paternò Award)** awarded by committee and INAF – Observatory of Catania.
2. *Title:* Wide Band Transmission of the Filters for the X-IFU detector of the Athena Space Observatory.
   Talk given on behalf of Dr. Michela Todaro at the International Conference on Space Optics – ICSO 2024, Antibes Juan-les-Pins, France (21-25 October 2024)
3. *Title:* Simulation of Point Spread Functions of EUV Entrance Filters for the NASA MUSE Mission.
   Talk given at The International Workshop on Physics of X-Ray and Neutron Multilayer Structures – PXRNMS2025, Università degli Studi di Padova, Padova (PD), Italy (9-11 Apr 2025)
4. *Title:* Optical performance of Aluminum-coated carbon nanotube pellicles for the NASA MUSE space mission. Talk given at the 111° National Congress of the Italian Physical Society (SIF), Università degli Studi di Palermo, Palermo (PA), Italy (22-26 Sep 2025)

<u>Invited talks:</u>

1. *Two oral presentations given at the MUSE Team meeting, ASI HQ Via del Politecnico snc, Rome, Italy (16-18 October 2023)*
   Title (I) : Spectroscopic characterization of DM small samples.
   Title (II): Extreme Ultraviolet Penning Discharge Source for MUSE's hardware testing.

2. *Title:* Filters, Meshes and EUV Sources Technology Advancement Activities for MUSE. Scientific seminar given as part of LMSAL seminars, Lockheed Martin Solar & Astrophysics Laboratory, B/203 Large Conf. Room, 3251 Hanover St, Palo Alto, CA 94306, USA (30 Nov 2023)
3. *Title:* Carbon Nanotube-Based Filters for the NASA MUSE Space Mission: Genesis, Testing and Diffraction. Seminar given at the Solar Physics Group Meeting at Stanford University, Cypress Conference Room, 466 Via Ortega, Stanford, California, 94305, USA (16 Jan 2024).
4. *Title:* The MUSE NASA Space Mission: Technology, Science and the Italian Contribution. Seminar given with G. Cozzo for the Cycle of Astrophysics Lessons (Ciclo di Lezioni di Astrofisica) organized by Prof. Rosario Iaria, AISF Palermo, and DIFC, in Aula B, Università degli Studi di Palermo, Via Archirafi 36 (27 Mar 2024)

Posters

1. *Title:* Innovative Optical Filters for EUV Coronal Spectroscopy. Published abstract (BIBCODE: 2023AGUFMSH31C2982A) and contributed poster at the American Geophysical Union 2023 Annual Meeting (AGU2023), Moscone Center, San Francisco, California, USA (11-15 Dec 2023)
2. *Title:* Investigation on the Role of Optical Filters on the Point Spread Function of the NASA MIDEX Solar Mission MUSE. Contributed poster at the International Conference on Space Optics – ICSO 2024, Antibes Juan-les-Pins, France (21-25 Oct 2024)

Attended Schools / Conferences / Workshops:

1. Attendance in person at the "Science with current and future solar physics missions" Workshop, held in ASI HQ Via del Politecnico snc, Rome, Italy (1-3 Feb 2023)
2. Attendance in person at the "ESA Academy's Product Assurance Awareness Training Course 2023" Training held in the ESA Academy's Training & Learning Facility, ESEC-Galaxia, Belgium (23-26 May 2023). Total lectures duration: 32 h. Certificate awarded after exam.
3. Attendance in person at the "XVII School on Synchrotron Radiation: Fundamentals, Methods and Applications" jointly organized by the Società Italiana di Luce di Sincrotrone (SILS) and Elettra - Sincrotrone Trieste ScpA, held in Muggia, Italy (16-26 Sep 2024). Certificate awarded.

Experimental Campaigns / Accepted Proposals:

1. Co-proposer of Accepted AHEAD2020 TNA Proposal. *Title*: XPS and XAS analysis of the zirconium and aluminum coated CNT filters studied for the NASA space solar mission MUSE (Principal Investigator, or PI: Pekka Törmä). Participation:
   I. In a Preparatory Visit (20-21 Apr 2023), in preparation for the XPS/XAS experimental campaign, Refs: Dr. Stefano Nannarone, and Dr. Elena Magnano.
   II. To the the XAS/XPS experimental campaign (27-31 May 2023).

   At the Elettra Sincrotrone Trieste, beamlines BEAR and BACH, Basovizza, Trieste (TS).
2. Participation in presence to the experimental campaign "Preliminary Vibration Test Campaign on MUSE OBF meshes" (PI: Fabio D'Anca), carried out at the SERMS s.r.l, Strada di Pentima 8, 05100 Terni TR (05-09 Jun 2023).
3. Co-proposer of Accepted proposal (#20221457) to SOLEIL Synchrotron. *Title:* VUV transmission response of the optical blocking filters for the Athena X-ray observatory. (PI: Michela Todaro). Participated in the experimental campaign (20-24 Jul 2023) at SOLEIL, DESIRS beamline, L'Orme des Merisiers Départementale 128, 91190 Saint-Aubin, France.
4. Co-proposer of Accepted AHEAD2020 TNA Proposal. *Title*: Vibration at qualification levels and contamination tests of composite materials of thin optical filter samples investigated for space missions. (PI: Fabio D'Anca, Sep 2023).
5. Participation in presence to the experimental campaign "MUSE Demonstration Model Optical Blocking Filters Qualification Vibration Test" (PI: Fabio D'Anca), carried out at SERMS s.r.l, Terni TR (26 Feb – 01 Mar 2024).

6. Main proposer and PI of Accepted proposal (#20231204) to SOLEIL Synchrotron, METROLOGIE beamline. *Title:* VUV and XAS transmission response analysis of the zirconium and aluminum-coated CNT filters studied for the NASA space solar mission MUSE. Participated in the experimental campaign (11-18 Mar 2024) at SOLEIL, Saint-Aubin, France.
7. Main proposer and PI of Accepted AHEAD2020 TNA Proposal. *Title:* Ellipsometric Spectroscopy analysis of the native oxide formed in Al / Zr / Mo / Ti / Nb coated CNT pellicles for applications in the MUSE NASA space mission. Participation:
   I. In a Preparatory Visit in preparation for ellipsometry campaigns in general, Refs: Dr. Fleury-Frenette Karl, Dr. Gailly Patrick. (24-29 Jun 2024).
   II. To the experimental campaign at the XAS and XPS experiments at the Elettra Sincrotrone Trieste, beamlines BEAR and BACH, Basovizza, Trieste (TS). (7-12 Jul 2024)

   At the Centre Spatial de Liège (CSL), Av. du Pré Aily 19, 4031 Liège, Belgium.
8. Co-proposed of Accepted AHEAD2020 TNA Proposal. *Title:* Ellipsometric characterization of Carbon Nanotube thin films as filters in space missions. (PI: Federico Fiorentino). Participated in person at the experimental campaign at CSL, Liège, Belgium (29 Sep – 05 Oct 2024)
9. Co-proposer of Accepted proposal (#20240810) to SOLEIL Synchrotron, METROLOGIE beamline. *Title:* X-ray transmission properties of optical blocking filters for MUSE NASA and ATHENA ESA space missions. (PI: Michela Todaro, Nov 2024).
10. Co-proposer of Accepted proposal (#20231525) to SOLEIL Synchrotron, AILES beamline. *Title:* IR shielding efficiency of the optical blocking filters for the Athena X-ray observatory. (PI: Michela Todaro). Participated in the experimental campaign (17-22 Mar 2025) at SOLEIL, Saint-Aubin, France.
11. Co-proposer of Accepted proposal (#20250770) to SOLEIL Synchrotron, METROLOGIE beamline. *Title:* X-ray transmission properties of the Structural and Thermal Model filters for the NASA MUSE solar mission and of prototype filters developed for the New Athena ESA space mission based on a challenging Carbon Nanotubes technology. (PI: Luisa Sciortino, Mar 2025).
12. Co-proposer of Accepted proposal (#20250875) to SOLEIL Synchrotron, METROLOGIE beamline. *Title:* X-ray transmission performance of various CNT pellicles metal-coated with different methods. (PI: Fiorentino Federico, Dec 2025).

Thesis title: Thin-film Filters for Solar Astrophysics: Science and Technology Development for the NASA MUSE Mission

Abstract:

Extreme ultraviolet (EUV) filters are key components for space missions to the solar environment, providing the necessary wavelength selection and attenuation of visible light. My thesis contributes to the optical and technological consolidation of the NASA MUSE (Multi-slit Solar Explorer) mission, an EUV solar observatory designed to probe coronal dynamics with unprecedented spatio-temporal resolution, with the main objective to enable the first observations of the EUV solar corona able to aid the require physical modeling in order to hone the theories answering open questions in astrophysics such as the Coronal Heating problem.

My dissertation aids the mission through the study, design, and characterization of thin-film input filters optimized for extreme ultraviolet (EUV) observations, while also proposing a few methodological contributions to the analysis of multi-slit spectral data. The work focuses on input filters for the spectrograph and context sensor, which must offer high EUV performance, high UV-VIS-IR rejection to prevent CCD degradation, limited diffraction-induced image degradation, and mechanical robustness for launch.

In Chapter 1, the Introduction, I introduce the state-of-the-art of thin film filters, their use in solar space missions, and discuss the role of diffraction, transmittance in various wavelength bands, and mechanical resistance. I also introduce the MUSE mission, its scientific objectives, and how this work contributes to the

consolidation of the mission's payload, and to advance the scientific and technological maturity of the thin films proposed.

In Chapter 2, I present the filters' designs, both based on heritage missions and on novel carbon nanotube (CNT) substrates, and introduce the techniques employed numerically to assess their diffraction impact at the focal plane of the mission. I conclude that the proposed CNT-based thin film filters can offer augmented performance diffraction-wise when compared to heritage-based solutions, while, in the channel pertaining to the Fe XV line of 284 Å, I show how a study of the trade-off between raw signal in the core encircled energy and relative intensity of the diffracted secondary peaks is required, since the CNT-based solutions produces less relative diffraction, while the heritage-based solution proves to be more intense at the core.

In Chapter 3, I discuss of the filters' visible performance, with a detailed description on the requirement definition and on the experimental assessment over aluminized small witness samples. I retrieve the requirement for the Context Imager telescope to be about $T < 10^{-6}$ in transmittance as a flat-bad requirement in the UV-VIS-IR range and discuss experimentally how all of the Al-coated designs satisfy this requirement, although the heritage-based filters do satisfy it with a greater margin.

In Chapter 4, I detail the transmittance of small witness samples of all designs (both Al-coated and Zr-coated, heritage-based and CNT-based) evaluated with experiments carried out with synchrotron radiation with X-ray Absorption Spectroscopy XAS to provide in-band transmittance curves and a description of the inner-layer compositional data analysis for the designs. More native-oxidation on the metal coatings deposited on CNT-substrates is seen, although, even with a worse oxidation, the CNT-based filters outperform heritage-based solutions with PI substrate in all channels in terms of raw transmittance. On the other hand, heritage-based solutions with no substrate remain the most transmissive of all samples in all channels. The results confirm the expected performance of heritage solutions and expands the knowledge over the new technology of CNT as a valid substrate for applications in astrophysics.

In Chapter 5, a technical note paragraph, I showcase the ongoing progress towards the development of an extreme ultraviolet EUV source, the Penning Discharge Source, for direct calibration purposes and of interest for MUSE.

The Conclusion rounds up the thesis.

Appendices do follow, serving the purpose of complementing the information provided throughout the main text. A special mention goes towards Appendix B, on the Bi-Gaussian Fitting Analysis approach, where I briefly introduce MUSE's data processing and information retrieval machinery, complementing almost entirely the experimental part, and I detail the development of a novel software strategy aiming to address some expected complexities. This approach demonstrated initial successes, possibly inspiring future approaches where the complexity of the data analysis, induced by the novelty of the multi-slit in MUSE, can be diminished or solved completely even with a simple physics-substantiated approach

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The PhD Board Dean

Prof. Marco Cannas

Marco Cannas

Allegato 6

PHD IN PHYSICAL AND CHEMICAL SCIENCES, XXXVIII COURSE

PhD Candidate: .....Carlotta Miceli.....

Transcript of Records

Tutor: Melania Del Santo

Cotutor: Julien Malzac

Courses/school/exam scores:

- Astrophysics laboratory of thermal X-ray plasmas
- Millisecond Pulsars: Theory and Observations
- Project management
- The transient Universe 2023, Cargese (school)

Research and training periods abroad

1,5 anni a Toulouse (Université de Toulouse, France) per accordo di cotutela

Papers published:
-Soft-state optical spectroscopy of the black hole MAXI J1305-704 (Miceli, C. et al 2024)
-Hβ spectroscopy of the high-inclination black hole transient Swift J1357.2–0933 during quiescence (Anitra et al. 2023)
- Confirmation of the presence of a CRSF in the NICER spectrum of X 1822-371 (Iaria et al. 2024)
- The puzzling orbital residuals of XTE J1710-281: Is a Jovian planet orbiting the binary system? (Iaria et al. 2024)
- X-ray view of emission lines in optical spectra: Spectral analysis of the two low-mass X-ray binary systems Swift J1357.2–0933 and MAXI J1305–704 (Anitra, A.; Miceli, C. et al 2024)
- X-Ray and Optical Polarization Aligned with the Radio Jet Ejecta in GX 339–4 (Mastroserio et al 2025)
- Swift observations of the new outburst of the BH transient 4U 1630-472 (Atel; Del Santo et al. 2025)
- Time domain astrophysics with transient sources: Delay estimate via Cross Correlation Function techniques (Leone et al 2025)
- A mysterious feature in the NICER spectrum of 4U 1820-30: A gravitationally redshifted absorption line? (Iaria et al 2025)

Conferences/workshop attended:

- Talks:
- 12th Young Researcher Meeting, Roma
- CNOC, Alghero 2024
- Vasto Accretion Meeting, 2025
- Journee de la SF2A, Toulouse (come LOC)
- Microquasar workshop 2025, Cefalù (anche come LOC)

Thesis title: Outflows in Black Hole X-ray binaries

Abstract:

Outflows are among the most important and complex phenomena shaping the evolution and observational appearance of black hole X-ray binaries. This thesis investigates their role through a multi-approach study of winds and compact jets under different physical conditions. Using optical spectroscopy of MAXI J1305–704, X-ray spectral analysis of GRS 1915+105, and advanced ISHEM modelling applied to MAXI J1535–571, it characterizes distinct forms of outflow and their connection to the underlying accretion flow. The results provide new insights into wind detection, the geometry of black hole binaries, and the structure and energetics of relativistic jets.

The PhD Board Dean

Prof. Marco Cannas