Lorenzo Mosesso

ABOUT ME

Currently a PhD student in Physics and Technology of Accelerators at the University of Rome La Sapienza, with a thesis project focused on the generation, collection, and application of Terahertz (THz) and Infrared (IR) radiation in particle accelerators. My research combines the field of Optical Engineering, through the design of IR beamlines in fourth-generation light sources, with the field of Materials Science, where THz/IR radiation is employed to study innovative materials/coatings for radiofrequency cavities.
I graduated in Physics with a Master's degree in Condensed Matter, with an experimental thesis on magnetic topological materials investigated via IR/THz spectroscopy.
My expertise includes several experimental techniques and applications, such as Optical and IR/THz spectroscopy, Raman spectroscopy, Pump/Probe methods, and Time-Domain THz spectroscopy, complemented by theoretical knowledge in Quantum Materials, Plasmonics, Photonics, and Nonlinear Optics.
These skills have been developed through extensive research activities carried out over the years with the Sapienza Terahertz group, as well as through collaborations with national and international research groups.
My future interests include the development of innovative THz/IR technologies in different fields, ranging from material science, condensed matter, biophysics and environmental science.

EDUCATION AND TRAINING

01/11/2022 – CURRENT Rome, Italy
PHD IN PHYSICS AND TECHNOLOGIES OF PARTICLE ACCELERATORS Sapienza, University of Rome

- Particle Accelerator based light sources
- 4th Generation Light Sources
- Material Science applied to particle accelerators

Field of study Physics | **Level in EQF** EQF level 8 |

Thesis Terahertz/Infrared Radiation: From the Production with Accelerator Based Sources to the Use in Material Characterization for Accelerator Cavities

01/09/2015 – 23/03/2022 Rome, Italy
MASTER DEGREE IN PHYSICS [LM - ORDIN. 2016] Sapienza, University of Rome

- IR and THz Spectroscopy
- Quantum Materials and Magnetic Topological Insulators

Field of study Physics | **Final grade** 110/110 Cum Laude | **Level in EQF** EQF level 7 | **Type of credits** CFU | **Number of credits** 120 |

Thesis Electrodynamics of the Magnetic Topological Insulator MnBi2Te4

01/09/2010 – 12/01/2016 Rome, Italy
BACHELOR DEGREE IN PHYSICS [L-270 - ORDIN. 2009] (CLASS L-30) Sapienza, University of Rome

- Condensed Matter

Field of study Physics | **Final grade** 109/110 | **Level in EQF** EQF level 6 |

Thesis Stati Elettronici Per Catene Poliatomiche Periodiche: Dal Benzene Alla Catena Lineare Infinita

WORK EXPERIENCE

UNIVERSITY OF ROME, ROMA TRE – ROMA, ITALY
Business or Sector Professional, scientific and technical activities | **Department** Department of Physics, Roma Tre, University of Rome

POST-GRADUATE SCHOLARSHIP – 23/05/2022 – 23/10/2022

Title of the Research: 'Development of a program for recognition and quantitative analysis of gaseous substances by IR spectroscopy'

LANGUAGE SKILLS

Mother tongue(s): **ITALIAN**

Other language(s):

	UNDERSTANDING		SPEAKING		WRITING
	Listening	Reading	Spoken production	Spoken interaction	
ENGLISH	C1	C1	C1	C1	C1

Levels: A1 and A2: Basic user; B1 and B2: Independent user; C1 and C2: Proficient user

SKILLS

Basic Computer Skills

Highly skilled in Office Automation (Word Processing, Spreadsheets, Web Browser) | Higly skilled in the following Programming languages: C/C++, MATLAB, Python | Basic knoweledge of Visual Basic and web programming | Basic knoweledge of Machine Learning and Deep Learning | Excellent use of Simulation Codes (SRW, Shadow) | Basic knoweledge of LabView

Graphic Design Skills

Excellent use of Vector Graphic Editor (Inkscape) | Basic use of 3D Creation Software (Blender)

Experimental Skills in Optical Spectroscopy (IR/Vis/Uv)

THz Time-Domain Spectroscopy (including expertise in designing and assembling optical setups) | Fourier Transform Infrared Spectroscopy (Bruker Instrumentation - VertexV70, Hyperion 2000) | Opus software for measurement, evaluation, and processing of IR and visible spectra | Spectrophotometry in Vis/UV (Jasco Instrumentation - Jasco v770) | Excellent use of RefFit software for data analysis | Cryogenic techniques applied to optical spectroscopy | Experimental pump-probe and non-linear optics techniques

PROJECTS

01/11/2023 – 01/11/2024
Avvio Alla Ricerca - Copper alloys for technological applications: a new route for improved Radiofrequency devices

Innovative acceleration schemes like plasma and more conventional ones like radiofrequency (RF) cavity require novel diagnostic methods and materials. The plasma density and its effective temperature, for instance, should be monitored in real time. This is actually done by measuring the light emission from the plasma which presents many limitations at low density, in particular near the plasma capillary edge. In RF cavity the main limitation in using high field gradients is the vacuum breakdown which damages surfaces reducing acceleration performances. Another problem is represented by the dark current, i.e., the electrons emitted by the metallic surfaces at high electric fields. All RF structures exhibit dark current after breakdown. These emitted electrons interfere with the accelerated charges affecting the beam quality. In addition to beam perturbation, this emission mechanism increases the heating of the cavities and may trigger further breakdowns. Although the breakdown phenomenon is still poorly understood, current consensus is that RF breakdown is enhanced by movements of crystal defects and strain induced by the periodic mechanical stress. The latter may be caused by the pulsed surface heating and by the presence of large electric fields.
The present project focuses on the study of novel materials with the application of different spectroscopic techniques to address the proposed limitations, creating a bridge between materials science, IR/THz optical spectroscopy, and particle acceleration. The main goal is a systematic investigation of innovative materials that are intended to enhance the performance of RF cavities, including high tensile strength, excellent electrical and thermal conductivity, and high breakdown voltages (on the order of gigavolts per meter). In this context, given that copper is the most widely used material for accelerating cavities, the first phase of the research will examine Cu/Ag alloys with varying silver concentrations, followed by copper samples coated with thin films having high work function oxides such as MoO_3 and WO_3.

CONFERENCES AND SEMINARS

02/07/2025 – 06/07/2025 Spain,Salamanca, University of Salamanca
TheraTech 2025

Oral Contribution:
'The Sabina Terahertz/Infrared beamline at the upgraded SPARC-Lab facility in Frascati, Italy'
Lorenzo Mosesso, Salvatore Macis, Stefano Lupi

Link https://www.teratech2025.usal.es/119633/detail/teratech-2025.html

26/05/2025 – 30/05/2025 France, Strasbourg, Convention & Exhibition Centre of Strasbourg
E-MRS Spring Meeting 2025

Oral Communication:

'Evidence of high electron mobility in magnetic kagome topological metal FeSn thin films'
Lorenzo Mosesso, Luca Tomarchio, Niraj Bhattarai, Salvatore Macis, Paola Gori, Mariangela Cestelli Guidi, John Philip, Olivia Pulci, Stefano Lupi

Link https://www.european-mrs.com/meetings/2025-spring-meeting

05/09/2024 – 07/09/2024 Italy, Rende, University of Calabria
SILS 2024 - Annual Conference

Oral Contribution:
'Design and Optimization of the IR Beamline SISSI 2.0 at the Elettra Synchrotron Facility'
Lorenzo Mosesso, Giovanni Birarda, Salvatore Macis, Lisa Vaccari, Stefano Lupi

Link https://sites.google.com/view/sils2024/home

26/08/2024 – 30/08/2024 Germany, Hamburg, DESY Conference
SRI 2024 (Synchrotron Radiation Instrumentation)

Oral Contribution:
'SABINA and SISSI 2.0: Two Underway Projects for Innovative THz/IR Sources based on Particle Accelerators'
Lorenzo Mosesso, Salvatore Macis, Stefano Lupi

Link https://www.sri2024.eu/

19/02/2024 – 20/02/2024 Italy, Naples, Federico II University of Naples
Teradays 2024

Oral Contribution:
'Underway Projects for Innovative THz/IR Sources based on Particle Accelerators: SISSI 2.0 and SABINA'
Lorenzo Mosesso, Salvatore Macis, Stefano Lupi

Link https://indico.unina.it/event/75/overview

29/01/2024 – 31/01/2024 Italy, Rome, Sapienza University of Rome
Physics and Topology

Oral Communication:
'Evidence of high electron mobility in magnetic Kagome metal FeSn Thin Films'
Lorenzo Mosesso, Luca Tomarchio, Salvatore Macis, Olivia Pulci, Paola Gori, Stefano Lupi

Link https://sites.google.com/uniroma1.it/physicsandtopology/?pli=1

30/08/2023 – 01/09/2023 Italy, Rome, Sapienza, University of Rome
SILS - Annual Conference

Oral Communication:
'The Sabina Terahertz/Infrared beamline at the SPARC-Lab facility'
Lorenzo Mosesso, Salvatore Macis, Stefano Lupi

Link https://www.lucedisincrotrone.it/sils-annual-conference-2023/

17/11/2022 – 18/11/2022 Italy, Rome, Sapienza, University of Rome
Teradays

Oral Communication:
'Electrodynamics in Magnetic Kagome Metal FeSn Thin Films'
Lorenzo Mosesso

PUBLICATIONS

2021
Low energy electrodynamics of CrI3 layered ferromagnet

We report on the optical properties from terahertz (THz) to Near-Infrared (NIR) of the layered magnetic compound CrI_3 at various temperatures, both in the paramagnetic and ferromagnetic phase. In the NIR spectral range, we observe an insulating electronic gap around 1.1 eV which strongly hardens with decreasing temperature. The blue shift observed represents a record in insulating materials and it is a fingerprint of a strong electron-phonon interaction. Moreover, a further gap hardening is observed below the Curie temperature, indicating the establishment of an effective interaction between electrons and magnetic degrees of freedom in the ferromagnetic phase. Similar interactions are confirmed by the disappearance of some phonon modes in the same phase, as expected from a spin-lattice interaction theory. Therefore, the optical properties of CrI_3 reveal a complex interaction among electronic, phononic and magnetic degrees of freedom, opening many possibilities for its use in 2-Dimensional heterostructures.

Tomarchio, L., Macis, S., Mosesso, L. et al. Low energy electrodynamics of CrI3 layered ferromagnet. Sci Rep 11, 23405 (2021). https://doi.org/10.1038/s41598-021-02918-4

Authors: Luca Tomarchio, Salvatore Macis, Lorenzo Mosesso, Loi T. Nguyen, Antonio Grilli, Mariangela Cestelli Guidi, Robert J. Cava & Stefano Lupi | **Journal Name**: Scientific Reports

2022

High sensitivity monitoring of VOCs in air through FTIR spectroscopy using a multipass gas cell setup

Human exposure to Volatile Organic Compounds (VOCs) and their presence in indoor and working environments is recognized as a serious health risk, causing impairments of varying severities. Different detecting systems able to monitor VOCs are available in the market; however, they have significant limitations for both sensitivity and chemical discrimination capability. During the last years we studied systematically the use of Fourier Transform Infrared (FTIR) spectroscopy as an alternative, powerful tool for quantifying VOCs in air. We calibrated the method for a set of compounds (styrene, acetone, ethanol and isopropanol) by using both laboratory and portable infrared spectrometers. The aim was to develop a new, and highly sensitive sensor system for VOCs monitoring. In this paper, we improved the setup performance, testing the feasibility of using a multipass cell with the aim of extending the sensitivity of our system down to the part per million (ppm) level. Considering that multipass cells are now also available for portable instruments, this study opens the road for the design of new high-resolution devices for environmental monitoring.

D'Arco, A. et al. High Sensitivity Monitoring of VOCs in Air through FTIR Spectroscopy Using a Multipass Gas Cell Setup. Sensors 2022, 22, 5624. https://doi.org/10.3390/s22155624

Authors: D'Arco, A.; Mancini, T.; Paolozzi, M.C.; Macis, S.; Mosesso, L.; Marcelli, A.; Petrarca, M.; Radica, F.; Tranfo, G.; Lupi, S.; Della Ventura, G.; | **Journal Name**: Sensors

2022

Electrodynamics of MnBi2Te4 intrinsic magnetic topological insulators

We report on the electrodynamics of $MnBi_2Te_4$ thin films, an intrinsic magnetic topological material. We study its optical conductivity from terahertz (THz) to ultraviolet (UV) frequencies as a function of the film thickness, highlighting the presence of surface topological states superimposed on the bulk electrodynamics response. For the thinnest film, where the charge transport is dominated by Dirac surface states, we investigate the effect of the phase transition from the high-temperature topological protected state to the low-temperature magnetic (time-reversal broken) state by measuring the optical conductivity across the Néel temperature. At low temperatures, the breaking of the time reversal symmetry affects the optical conductivity, indicating that a magnetic-induced gap opens below T_N.

Tomarchio, L., Mosesso, L., Macis, S. et al. Electrodynamics of MnBi2Te4 intrinsic magnetic topological insulators. NPG Asia Mater 14, 82 (2022). https://doi.org/10.1038/s41427-022-00429-w

Authors: Luca Tomarchio, Lorenzo Mosesso, Salvatore Macis, Antonio Grilli, Martina Romani, Mariangela Cestelli Guidi, Kejing Zhu, Xiao Feng, Michele Zacchigna, Massimo Petrarca, Ke He & Stefano Lupi | **Journal Name**: npg Asia Materials

2023

THz Generation from the Topological Nodal Line Semimetal Co2MnGa

Nonlinear optical spectroscopy is a fundamental probe for the investigation of topological effects in quantum materials. In this paper, we report on the terahertz (THz) emission from thin films at various thicknesses of the magnetic topological nodal semimetal Co_2MnGa (CMG) when excited by femtosecond optical pulses. Experimental results suggest the presence of multiple THz generation mechanisms, originating from both bulk and surface states of CMG. The former is explained in terms of a photon-drag effect as induced by radiation pressure. The latter emission mechanism instead appears to be related to the photovoltaic effect coming from the topological surface states. This interplay between generation mechanisms indicates that Co_2MnGa topological nodal semimetals are a valuable platform for THz emitter devices.

Luca Tomarchio, Sen Mou, Lorenzo Mosesso, Anastasios Markou, Edouard Lesne, Claudia Felser, and Stefano Lupi ACS Applied Electronic Materials 2023 5 (3), 1437-1443 DOI: 10.1021/acsaelm.2c01376

Authors: Luca Tomarchio, Sen Mou, Lorenzo Mosesso, Anastasios Markou, Edouard Lesne, Claudia Felser, Stefano Lupi | **Journal Name**: ACS Applied Electronic Materials

2023

Phonon Anharmonicity and Spin–Phonon Coupling in CrI3

We report on the far-infrared, temperature-dependent optical properties of a CrI_3 transition metal halide single crystal, a van der Waals ferromagnet (FM) with a Curie temperature of 61 K. In addition to the expected phonon modes determined by the crystalline symmetry, the optical reflectance and transmittance spectra of CrI_3 single crystals show many other excitations as a function of temperature as a consequence of the combination of a strong lattice anharmonicity and spin–phonon coupling. This complex vibrational spectrum highlights the presence of entangled interactions among the different degrees of freedom in CrI_3.

Materials 2023, 16(14), 4909; https://doi.org/10.3390/ma16144909

Authors: Luca Tomarchio, Lorenzo Mosesso, Salvatore Macis, Loi T. Nguyen, Antonio Grilli, Martina Romani, Mariangela Cestelli Guidi, Robert J. Cava, Stefano Lupi | **Journal Name**: Materials

2024

Evidence of high electron mobility in magnetic kagome topological metal FeSn thin films

We present a systematic study of the low-energy electrodynamics of the magnetic FeSn kagome metal, which hosts both topological (Dirac) and non-trivial states. Our results reveal that the optical conductivity of FeSn shows two Drude contributions that can be associated with the linear (Dirac) and parabolic (massive) bands, with a dominance of the former to the DC conductivity at low temperatures. The weight of the Drude response shifts toward lower frequencies upon cooling due to a rapid increase in the Dirac electron mobility, which we associate with a temperature suppression of e–ph scattering. The experimental interband dielectric function is in very good agreement with that calculated within Density Functional Theory (DFT). These results provide a full description of the charge dynamics in FeSn kagome topological metal, opening the road for its use in photonic and plasmonic applications.

DOI: 10.1039/D4NA00737A (Paper) Nanoscale Adv., 2024, 6, 6378-6385

Authors: Lorenzo Mosesso, Luca Tomarchio, Niraj Bhattarai, Salvatore Macis, Paola Gori, Antonio Grilli, Mariangela Cestelli Guidi, John Philip, Olivia Pulci and Stefano Lupi | **Journal Name**: Nanoscale Advances

2024

Characterization of CuAg Alloys with Low Ag Concentrations

Copper-based alloys designed to combine high electronic and thermal conductivities with high mechanical strength find a wide range of applications in different fields. Among the principal representatives, strongly diluted CuAg alloys are of particular interest as innovative materials for the realization of accelerating structures when the use of high-gradient fields requires increasingly high mechanical and thermal performances to overcome the limitations induced by breakdown phenomena. This work reports the production and optical characterization of CuAg crystals at low Ag concentrations, from 0.028% wt to 0.1% wt, which guarantee solid solution hardening while preserving the exceptional conductivity of Cu. By means of Fourier Transform Infrared (FTIR) micro-spectroscopy experiments, the low-energy electrodynamics of the alloys are compared with that of pure Cu, highlighting the complete indistinguishability in terms of electronic transport for such low concentrations. The optical data are further supported by Raman micro-spectroscopy and SEM microscopy analyses, allowing the demonstration of the full homogeneity and complete solubility of solid Ag in copper at those concentrations. Together with the solid solution hardening deriving from the alloying process, these results support the advantage of strongly diluted CuAg alloys over conventional materials for their application in particle accelerators.

Mosesso, L.; Macis, S.; D'Arco, A.; Marcelli, A.; Notargiacomo, A.; Pea, M.; Spataro, B.; Stagno, V.; Lupi, S. Characterization of CuAg Alloys with Low Ag Concentrations. Materials 2024, 17, 1823. https://doi.org/10.3390/ma17081823

Authors: Mosesso, L.; Macis, S.; D'Arco, A.; Marcelli, A.; Notargiacomo, A.; Pea, M.; Spataro, B.; Stagno, V.; Lupi, S. | **Journal Name**: Materials

2024

Anisotropic Optical Response of Ti-Doped VO2 Single Crystals

This study delves into the effects of titanium (Ti) doping on the optical properties of vanadium dioxide (VO_2), a material well known for its metal–to–insulator transition (MIT) near room temperature. By incorporating Ti into VO_2's crystal lattice, we aim to uncover the resultant changes in its physical properties, crucial for enhancing its application in smart devices. Utilizing polarized infrared micro–spectroscopy, we examined $Ti_xV_{1-x}O_2$ single crystals with varying Ti concentrations (x = 0.059, x = 0.082, and x = 0.187) across different crystal phases (the conductive rutile phase and insulating monoclinic phases M1 and M2) from the far–infrared to the visible spectral range. Our findings reveal that Ti doping significantly influences the phononic spectra, introducing absorption peaks not attributed to pure VO_2 or TiO_2. This is especially notable with polarization along the crystal growth axis, mainly in the x = 0.187 sample. Furthermore, we demonstrate that the electronic contribution to optical conductivity in the metallic phase exhibits strong anisotropy, higher along the c axis than the a–b plane. This anisotropy, coupled with the progressive broadening of the zone center infrared active phonon modes with increasing doping, highlights the complex interplay between structural and electronic dynamics in doped VO_2. Our results underscore the potential of Ti doping in fine-tuning VO_2's electronic and thermochromic properties, paving the way for its enhanced application in optoelectronic devices and technologies.

Macis, S.; Mosesso, L.; D'Arco, A.; Perucchi, A.; Di Pietro, P.; Lupi, S. Anisotropic Optical Response of Ti-Doped VO2 Single Crystals. Materials 2024, 17, 3121. https://doi.org/10.3390/ma17133121

Authors: Macis, S.; Mosesso, L.; D'Arco, A.; Perucchi, A.; Di Pietro, P.; Lupi, S. | **Journal Name**: Materials

2024

Terahertz and Infrared Plasmon Polaritons in PtTe2 Type-II Dirac Topological Semimetal

Surface plasmon polaritons (SPPs) are electromagnetic excitations existing at the interface between a metal and a dielectric. SPPs provide a promising path in nanophotonic devices for light manipulation at the micro and nanoscale with applications in optoelectronics, biomedicine, and energy harvesting. Recently, SPPs are extended to unconventional materials like graphene, transparent oxides, superconductors, and topological systems characterized by linearly dispersive electronic bands. In this respect, 3D Dirac and Weyl semimetals offer a promising frontier for infrared (IR) and terahertz (THz) radiation tuning by topologically-protected SPPs. In this work, the THz-IR optical response of platinum ditelluride ($PtTe_2$) type-II Dirac topological semimetal films grown on Si substrates is investigated. SPPs generated on microscale ribbon arrays of $PtTe_2$ are detected in the far-field limit, finding an excellent agreement among measurements, theoretical models, and electromagnetic simulation data. The far-field measurements are further supported by near-field IR data which indicate a strong electric field enhancement due to the SPP excitation near the ribbon edges. The present findings indicate that the $PtTe_2$ ribbon array appears an ideal active layout for geometrically tunable SPPs thus inspiring a new fashion of optically tunable materials in the technologically demanding THz and IR spectrum.

S. Macis, A. D'Arco, L. Mosesso, et al. Terahertz and Infrared Plasmon Polaritons in PtTe2 Type-II Dirac Topological Semimetal. Adv. Mater. 2024, 36, 2400554. https://doi.org/10.1002/adma.202400554

Authors: S. Macis, A. D'Arco, L. Mosesso, M. C. Paolozzi, S. Tofani, L. Tomarchio, P. P. Tummala, S. Ghomi, V. Stopponi, E. Bonaventura, C. Massetti, D. Codegoni, A. Serafini, P. Targa, M. Zacchigna, A. Lamperti, C. Martella, A. Molle, S. Lupi | **Journal Name**: Advanced Materials

2024

Optical Conductivity and Photo-Induced Polaronic Formation in Co2MnGa Topological Semimetal

Topological materials occupy an important place in the quantum materials family due to their peculiar low-energy electrodynamics, hosting emergent magneto-electrical, and nonlinear optical responses. This manuscript reports on the optical responses for the magnetic topological nodal semimetal Co_2MnGa, studied in a thin film geometry at various thicknesses. The thickness-dependent optical conductivity is investigated, observing a substantial dependence of the electronic band structure on thickness. Additionally, details on the ultrafast response of the low energy excitations in the terahertz frequency are reported by employing optical pump-terahertz probe (OPTP) spectroscopy. In particular, the photocarrier dynamics of Co_2MnGa thin films is studied at varying pump fluence, pump wavelength, and film thickness, observing a negative THz photoconductivity which is assigned to a dynamical formation of large polarons in the material.

L. Tomarchio, S. Macis, S. Mou, L. Mosesso, A. Markou, E. Lesne, C. Felser, S. Lupi, Optical Conductivity and Photo-Induced Polaronic Formation in Co2MnGa Topological Semimetal. Adv. Sci. 2024, 11, 2400247. https://doi.org/10.1002/advs.202400247

Authors: Luca Tomarchio, Salvatore Macis, Sen Mou, Lorenzo Mosesso, Anastasios Markou, Edouard Lesne, Claudia Felser, Stefano Lupi | **Journal Name**: Advanced Science

2024

Light-driven electrodynamics and demagnetization in FenGeTe2 (n = 3, 5) thin films

Two-dimensional materials-based ultrafast spintronics are expected to surpass conventional data storage and manipulation technologies, that are now reaching their fundamental limits. The newly discovered van der Waals (VdW) magnets provide a new platform for ultrafast spintronics since their magnetic and electrical properties can be tuned by many external factors, such as strain, voltage, magnetic field, or light absorption for instance. Here, we report on the direct relationship between magnetic order and Terahertz (THz) electrodynamics in Fe_nGeTe_2 (n = 3, 5) (FGT) films after being illuminated by a femtosecond optical pulse, studying their ultrafast THz response as a function of the optical pump-THz probe temporal delay. In Fe_5GeTe_2, we find clear evidence that light-induced electronic excitations directly influence THz electrodynamics similarly to a demagnetization process, contrasting with the effects observed in Fe_3GeTe_2, which are characterized by a thermal energy transfer among electrons, magnons, and phonons. We address these effects as a function of the pump fluence and pump-probe delay, and by tuning the temperature across the magnetic ordering Curie temperature, highlighting the microscopic mechanisms describing the out-of-equilibrium evolution of the THz conductivity. Finally, we find evidence for the incoherent-coherent crossover predicted by the Kondo-Ising scenario in Fe_3GeTe_2 and successfully simulate its light-driven electrodynamics through a three-temperature model. As indicated by these results, FGT surpasses conventional metals in terms of modulating their properties using an optical lever.

Tomarchio, L., Polewczyk, V., Mosesso, L. et al. Light-driven electrodynamics and demagnetization in FenGeTe2 (n = 3, 5) thin films. npj 2D Mater Appl 8, 73 (2024). https://doi.org/10.1038/s41699-024-00510-8

Authors: Luca Tomarchio, Vincent Polewczyk, Lorenzo Mosesso, Alain Marty, Salvatore Macis, Matthieu Jamet, Frédéric Bonell, Stefano Lupi | **Journal Name**: npj 2D Materials and Applications

2025

Ultrahigh-sensitive and real-time detection of BTXs for occupational safety via infrared spectroscopy coupled with machine learning technique

Exposure to Volatile Organic Compounds (VOCs) is one of the major human and occupational safety concern, as possible human carcinogens. Several gold standard methods are used for their detection in the atmosphere; however, most of them operate ex-situ or do not provide easy discrimination between different molecules with suitable sensitivity. Here, we introduce an ultrasensitive method based on Fourier Transform Infrared (FTIR) spectroscopy coupled with Machine Learning (ML) algorithms to analyse toxic gaseous substances in working sites down to a concentration of less than 1 ppm. We investigate six selected aromatic compounds (BTXs gases and styrene), building an accurate IR gas-phase database and providing, for the first time at the best of our knowledge, universal IR calibration curves still lacking in literature. Starting from this IR gas-phase database, we design and train a ML automatic and rapid recognition method. This advantageous combination between IR spectroscopy, including the estimated IR calibration curves, and ML algorithms demonstrates the strong ability of our strategy in discriminating between different gaseous VOCs indoor, with high accuracy and rapidity even when more compounds are present at the same time. The proposed approach responds to the fundamental needs (i) to evaluate low VOCs concentrations up to values less than 1 ppm (under the legislative levels), (ii) to monitor the VOCs presence in real-time for the accurate estimation of long-exposure levels and (iii) to discriminate the co-exposure at various compounds.

Tiziana Mancini et al., Journal of Environmental Chemical Engineering, Volume 13, Issue 3, 2025, 116833, ISSN 2213-3437, https://doi.org/10.1016/j.jece.2025.116833.

Authors: Tiziana Mancini, Francesco Radica, Lorenzo Mosesso, Maria Chiara Paolozzi, Salvatore Macis, Augusto Marcelli, Stefano Tamascelli, Giovanna Tranfo, Giancarlo Della Ventura, Stefano Lupi, Annalisa D'Arco, | **Journal Name**: Journal of Environmental Chemical Engineering | **Volume, Issue and Pages**: Volume 13, Issue 3

2025

Dual Optical Hyperbolicity of PdCoO2 and PdCrO2 Delafossite Single Crystals

Hyperbolic materials exhibit a very peculiar optical anisotropy with simultaneously different signs of the dielectric tensor components. This anisotropy allows the propagation of exotic surface-wave excitations like hyperbolic phonons and plasmon polaritons. While hyperbolic materials hold promise for applications in subwavelength photonics and enhanced light-matter

interactions, their natural occurrence is limited to a few materials, often accompanied by significant dielectric losses and limited hyperbolic spectral bandwidth. Focusing on $PdCoO_2$ and $PdCrO_2$ delafossite transition-metal oxides, in this paper unique dual hyperbolic regimes are demonstrated:: one localized around a phonon absorption in the mid-infrared spectral region, and the other extending into the visible range. Both hyperbolic regimes show exceptional properties including low dissipation and high hyperbolic quality factors. These results pave the way for innovative applications of delafossite layered metals in subwavelength photonics, imaging, and sensing.

S. Macis, A. D'Arco, E. Del Re, L. Mosesso, M. C. Paolozzi, V. Stagno, A. McLeod, Y. Tao, P. Jain, Y. Zhang, F. Tutt, M. Centini, M. C. Larciprete, C. Leighton, S. Lupi, . Adv. Funct. Mater. 2025, e12820. https://doi.org/10.1002/adfm.202512820

Authors: Salvatore Macis, Annalisa D'Arco, Eugenio Del Re, Lorenzo Mosesso, Maria Chiara Paolozzi, Vincenzo Stagno, Alexander McLeod, Yu Tao, Pahuni Jain, Yi Zhang, Fred Tutt, Marco Centini, Maria Cristina Larciprete, Chris Leighton, Stefano Lupi | **Journal Name**: Advanced Functional Materials

2025
Few-cycle THz Pulse Generation in DSTMS Crystal Pumped by a 8.3-MHz Amplified Mamyshev Oscillator

Mamyshev oscillators are an emerging class of ultrafast fiber lasers that support exceptionally broadband spectra and few-femtosecond pulse durations, making them well-suited for nonlinear frequency conversion. Despite this potential, THz generation using Mamyshev oscillators has not been demonstrated to date. In this work, we report the generation of THz few-cycle at 8.3 MHz repetition rate via optical rectification of a 31-fs pulse duration, 1-W average power amplified Mamyshev oscillator in a 190-um-thick DSTMS organic crystal. We measured a THz average power of 40 uW and a spectral bandwidth of 4 THz. To further investigate the advantage of combining Mamyshev oscillator and organic crystals for THz generation at multi-MHz repetition rate, we compared the THz pulses with those generated using a conventional inorganic 500 um-thick GaP crystal, obtaining comparable bandwidth, but 20 times lower power with respect to DSTMS.

https://doi.org/10.48550/arXiv.2507.19148

Authors: Francesco Canella, Dario Giannotti, Sara Pizzurro, Riccardo Gotti, Lorenzo Mosesso, Stefano Lupi, Antonio Agnesi, Federico Pirzio, Gianluca Galzerano

DRIVING LICENCE

Driving Licence: B

SCHOOL ATTENDANCE

09/01/2023 – 10/02/2023
Joint Universities Accelerator School (European Scientific Institute)

Lectures (75h25)
- Reminder on Special relativity & Electromagnetism
- Transverse Beam Dynamics
- Longitudinal Beam Dynamics
- MADX
- PyHeadTail
- Linacs
- Transverse Linear Imperfections
- Cyclotrons & FFAs
- Synchrotron Radiation
- Transverse non-linear effects
- Injection / Extraction
- Accelerator Design
- Collective effects (Space charge and instabilities)

Seminars (12h00)
- Particle Accelerators in the 21st century
- Introduction to CERN & its Accelerator Complex
- Collider's session
- Transverse non-linear manipulations
- Free-Electron Lasers
- Beam-based impedance measurements
- Novel High Gradient Particle Accelerators
- CERN LIU Project: Beam Dynamics aspects &solutions
- I-FAST-CBI: Challenge based innovation for particle accelerators & related technologies

Visits (6h45)
- CERN LEIR Accelerator
- ALICE Experiment at the CERN LHC
- European Synchrotron Radiation Facility (ESRF)

Workshops (18h30)
- MADX
- PyHeadTail
- Accelerator Design

Completed course work and examinations resulting in:

Overall mark of student (out of 20): 15,64

Link https://esi-archamps.eu/juas-presentation/