

CORSO DI LAUREA MAGISTRALE IN FISICA

OPPORTUNITA' DIDATTICHE AREA SPERIMENTALE

CORSI TIPICAMENTE «SPERIMENTALI»:

TECNICHE DI FRONTIERA SORRETTE DA PRINCIPI FISICI AVANZATI

DESIGN ED INTERPRETAZIONE DI PROTOCOLLI SPERIMENTALI

LABORATORY OF NUCLEAR AND SUB-NUCLEAR PHYSICS

NANO-PARTICLES AND NANO-STRUCTURES

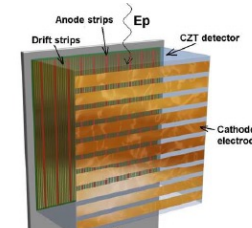
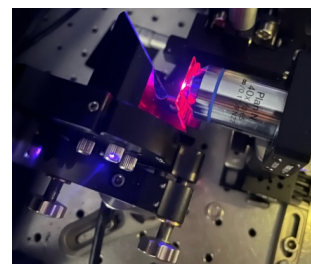
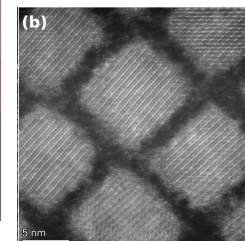
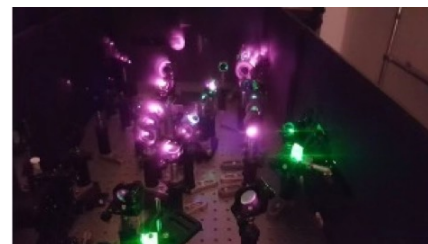
BIOPHOTONICS WITH LABORATORY

LAB OF PHYSICS OF MATTER

RADIATION DETECTORS WITH LAB

FISICA DEGLI STATI CONDENSATI

BIOPHYSICS



MA ANCHE TANTI ALTRI...

ES. QUANTUM OPTICS, STRUCTURE OF MATTER ADVANCED COURSE, ...

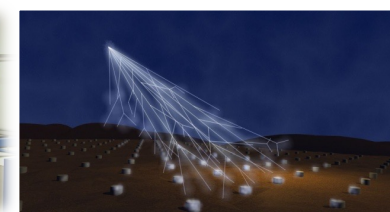
TESI: 30 CFU

PROBLEMA DI RICERCA

AMPIO VENTAGLIO DI TEMATICHE OGGETTO DELLA RICERCA DIPARTIMENTALE.

NUMEROSI LABORATORI DIPARTIMENTALI «STATE OF THE ART».

COLLABORAZIONI SCIENTIFICHE, GRANDI FACILITIES DI RICERCA, ETC..



UNIVERSITÀ
DEGLI STUDI
DI PALERMO

LABORATORY «ROBERTO BOSCAINO» OF ADVANCED MATERIALS:

MARCO CANNAS, SIMONPIETRO AGNELLO, GIANPIERO BUSCARINO, FABRIZIO MESSINA, ALICE SCIORTINO, EMANUELE MARINO

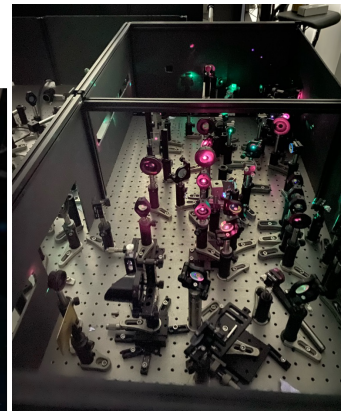
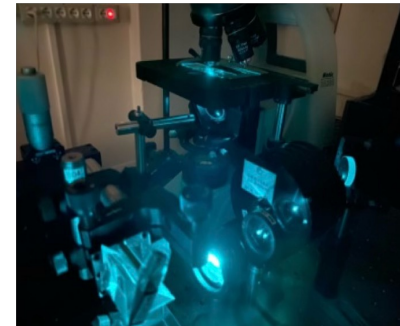
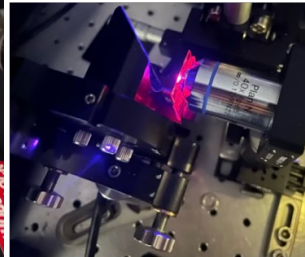
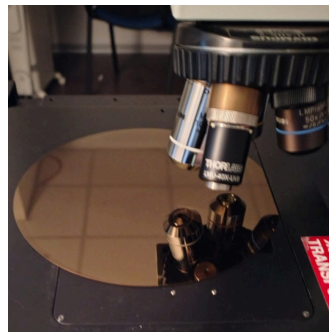
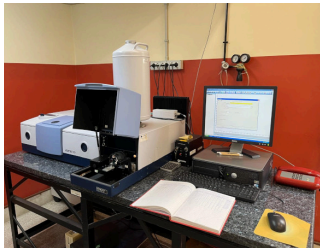
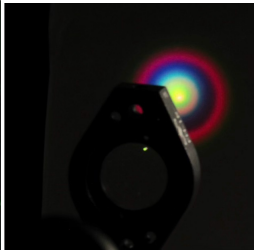
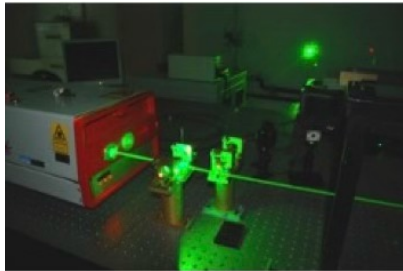
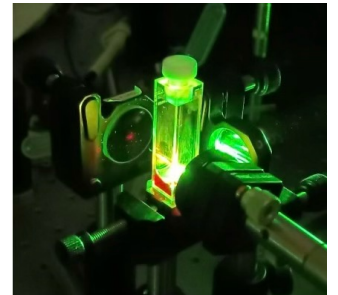


RESEARCH TOPICS:

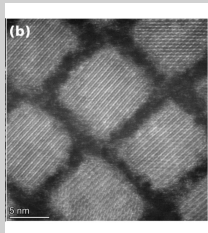
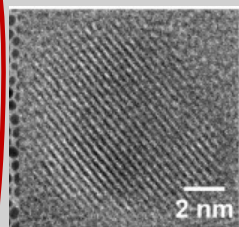
- QUANTUM PROPERTIES OF MATERIALS AT THE NANOSCALE
- QUANTUM-CONFINED MATERIALS: 0D, 1D, 2D, 3D
- MESO-SCALE ARTIFICIAL MATERIALS
- LIGHT-MATTER INTERACTIONS
- EFFECTS INDUCED BY IRRADIATION, DOPING, THERMAL TREATMENTS, ...
- FUNDAMENTAL PHYSICS WITH A DRIVE TOWARDS EMERGING TECHNOLOGIES

TECHNIQUES:

- OPTICAL SPECTROSCOPIES: ABSORPTION, PHOTOLUMINESCENCE
- VIBRATIONAL SPECTROSCOPY: RAMAN AND INFRARED
- TIME-RESOLVED OPTICAL SPECTROSCOPY (NS, PS, FS)
- OPTICAL MICROSCOPY METHODS
- ELECTRON PARAMAGNETIC RESONANCE
- ATOMIC FORCE MICROSCOPY, ELECTRON MICROSCOPY, ...

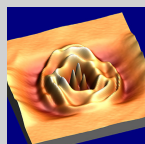


SEMICONDUCTOR NANOCRYSTALS



$$\Psi_{n,l,m_l}(r, \vartheta, \varphi) = \frac{C}{r} j_l(k_{n,l} r) Y_l^{m_l}(\vartheta, \varphi)$$

$$E_{ehp}(n_e, l_e, n_h, l_h) = E_g + \frac{\hbar^2}{2a^2} \left\{ \frac{\alpha_{n_e, l_e}^2}{m_e} + \frac{\alpha_{n_h, l_h}^2}{m_h} \right\} - E_c$$

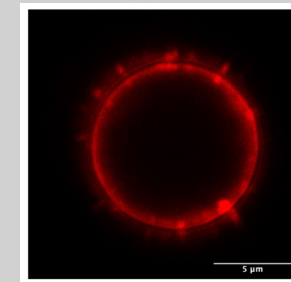
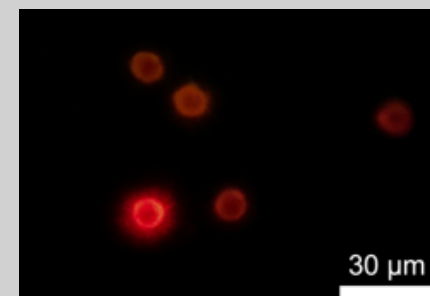


QUANTUM DOTS (QDs):

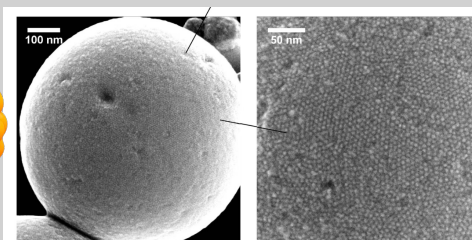
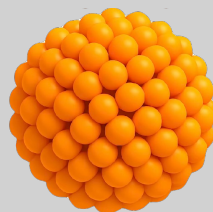
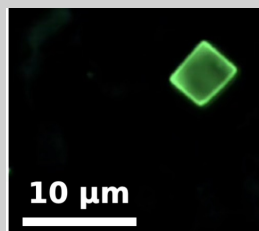
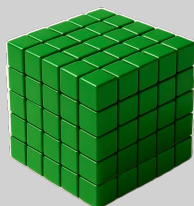
- QUANTUM BEHAVIOUR FROM NANOSCALE TO MESOSCALE
- BEHAVIOUR OF MATTER AT THE NANOSCALE
- OPTICAL & STRUCTURAL PROPERTIES
- RELAXATION DYNAMICS OF PHOTOEXCITED STATES
- PHOTONIC RESPONSE



LASERS, MICROLASERS, ACTIVE MICRORESONATORS



MESOSCALE ARTIFICIAL MATERIALS BUILT FROM QDs

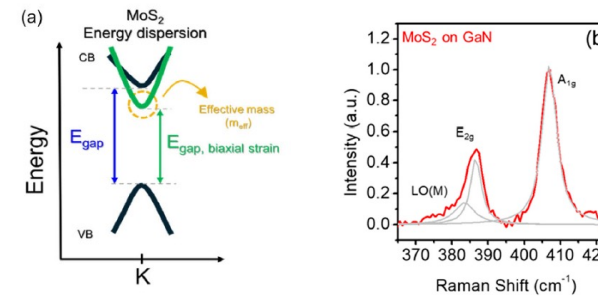
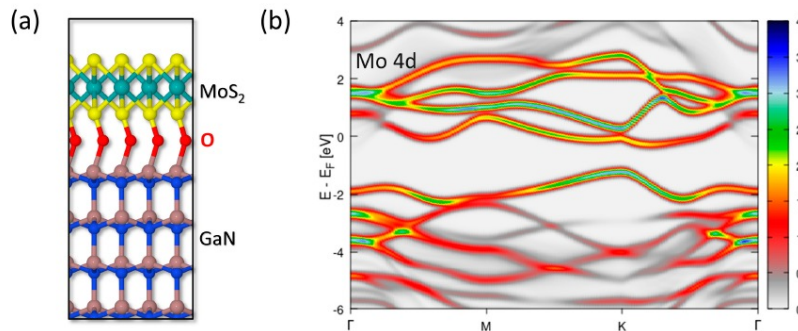
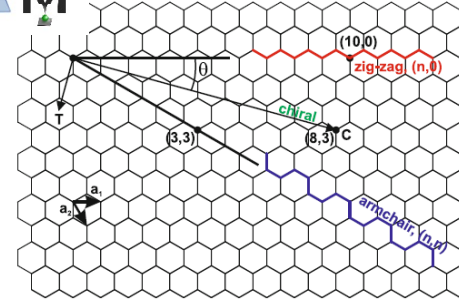


2D Materials

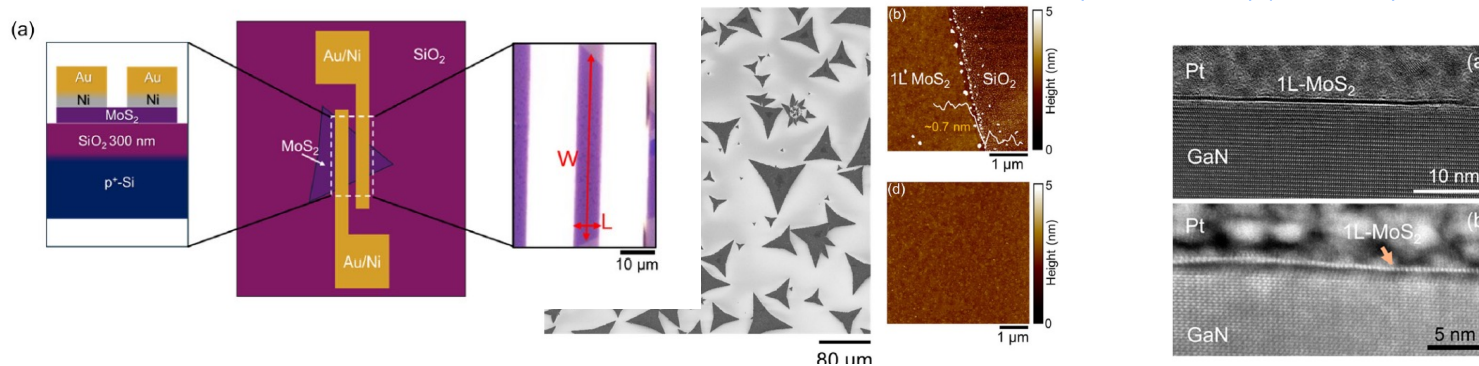


Hot topics:

- Band structure and electronic states
- Stability by thermal stress- irradiation
- Optical & structural properties
- Doping strategies
- Innovative quantum devices



Experimental characterization Spectroscopy + morphology



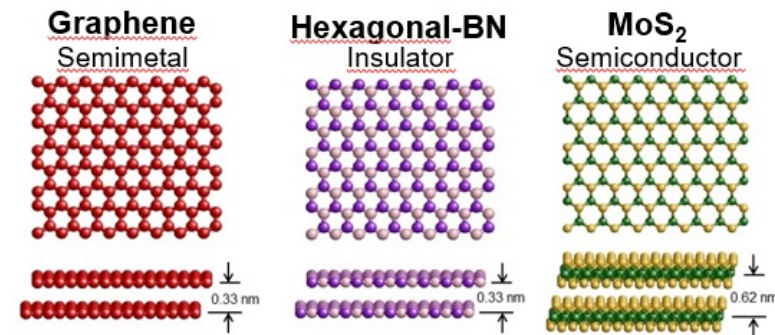
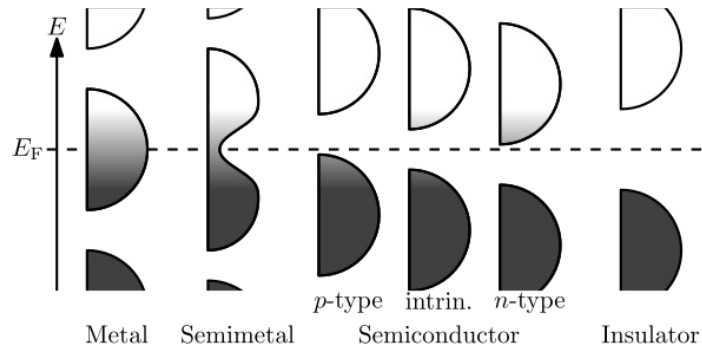
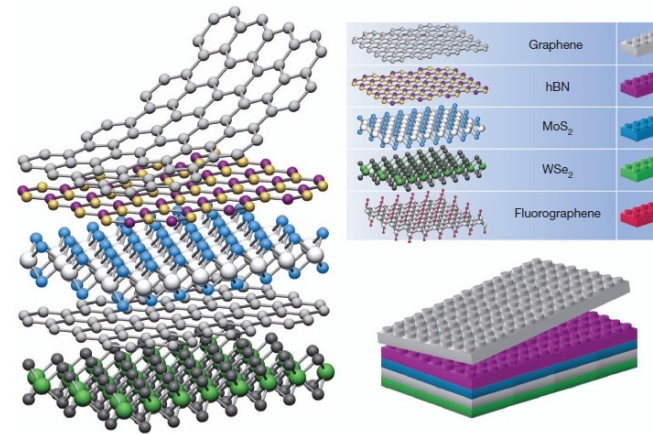
2D Materials



Van der Waals heterostructures

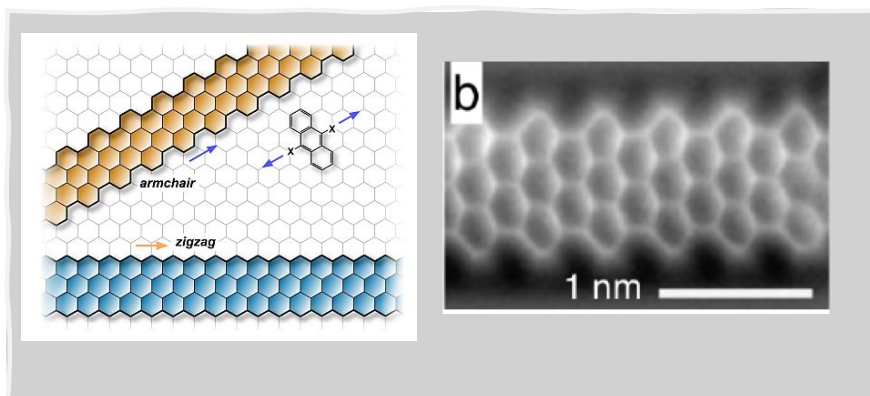
A. K. Geim^{1,2} & I. V. Grigorieva¹

Graphene family	Graphene	hBN 'white graphene'	BCN	Fluorographene	Graphene oxide
2D chalcogenides	MoS ₂ , WS ₂ , MoSe ₂ , WSe ₂	Semiconducting dichalcogenides: MoTe ₂ , WTe ₂ , ZrS ₂ , ZrSe ₂ and so on		Metallic dichalcogenides: NbSe ₂ , NbS ₂ , TaS ₂ , TiS ₂ , NiSe ₂ and so on Layered semiconductors: GaSe, GaTe, InSe, Bi ₂ Se ₃ and so on	
2D oxides	Micas, BSCCO	MoO ₃ , WO ₃	Perovskite-type: LaNb ₂ O ₇ , (Ca,Sr) ₂ Nb ₃ O ₁₀ , Bi ₄ Ti ₃ O ₁₂ , Ca ₂ Ta ₂ TiO ₁₀ and so on		Hydroxides: Ni(OH) ₂ , Eu(OH) ₂ and so on
	Layered Cu oxides	TiO ₂ , MnO ₂ , V ₂ O ₅ , TaO ₃ , RuO ₂ and so on			Others



Applications in electronics,
optoelectronics, catalysts,
sensors, solar cells.

GRAPHENE NANORIBBONS

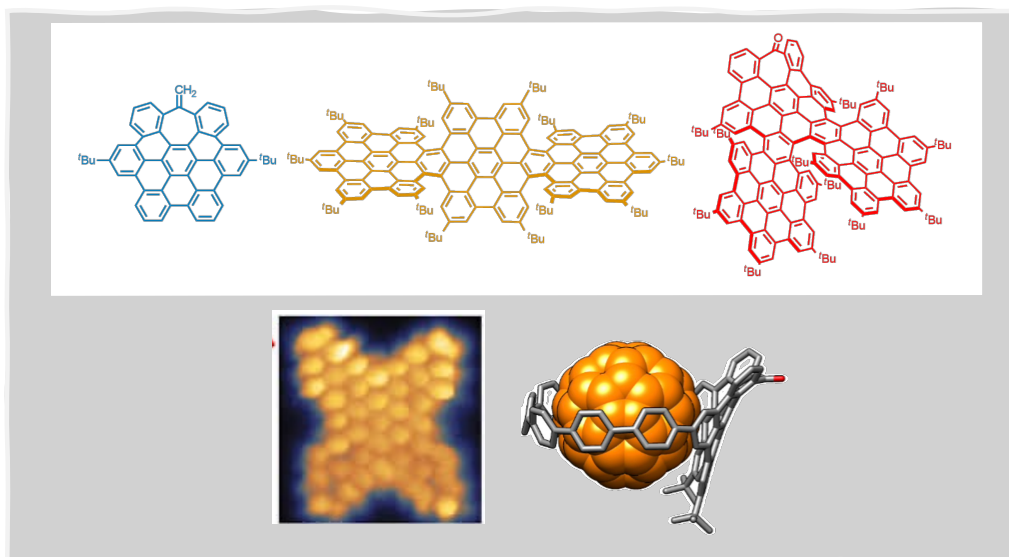


NANOGRAPHENES:

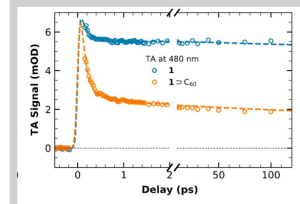
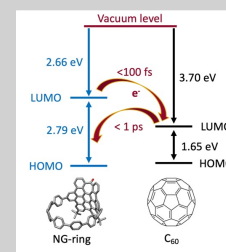
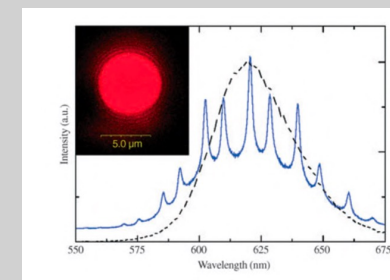
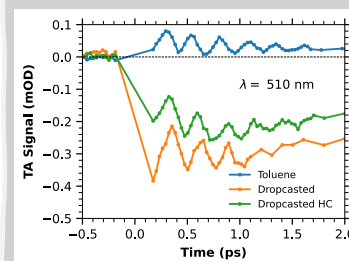
- QUANTUM BEHAVIOUR FROM 2D + 0D CONFINEMENT
- NON-TRIVIAL PROPERTIES OF CARBON-BASED NANOMATERIALS
- MESOSCALE QUANTUM PROPERTIES
- EFFECT OF STRUCTURAL DISTORTION ON FUNDAMENTAL PHOTOPHYSICS
- PHOTOEXCITED DYNAMICS



DISTORTED NANOGRAPHENES, NANOGRAPHENE COMPOSITES

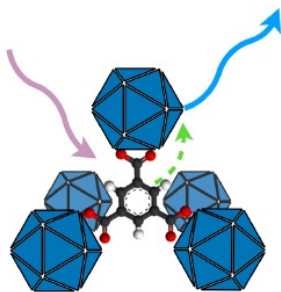


QUANTUM COHERENCE, COUPLING TO MICRORESONATOR ULTRAFAST ELECTRON MIGRATION

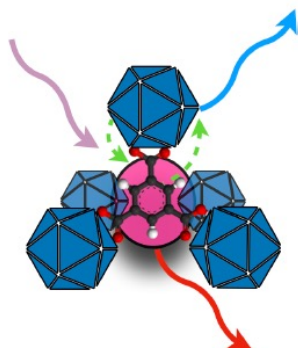


Quantum Photophysics of (Luminescent) Metal Organic Frameworks

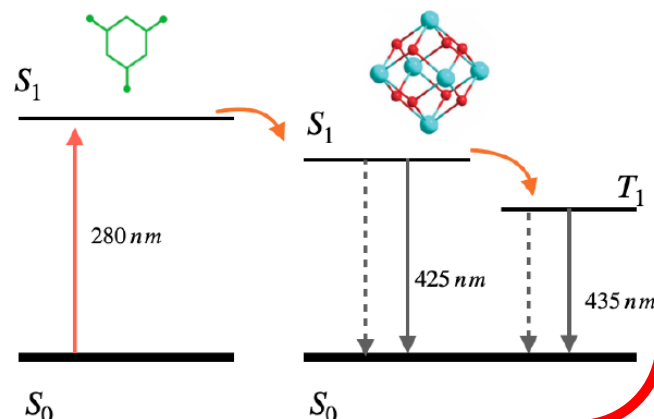
MOF-808



RhB@MOF-808



Photophysical Model

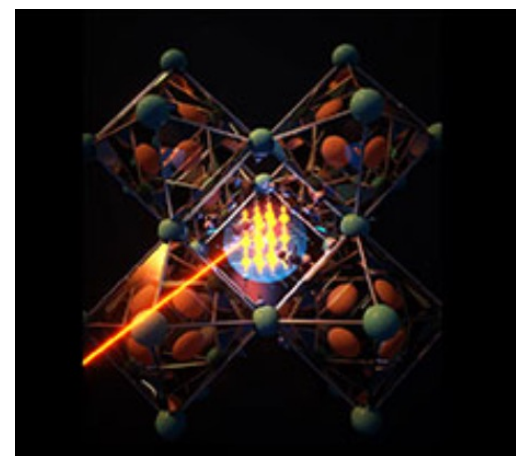
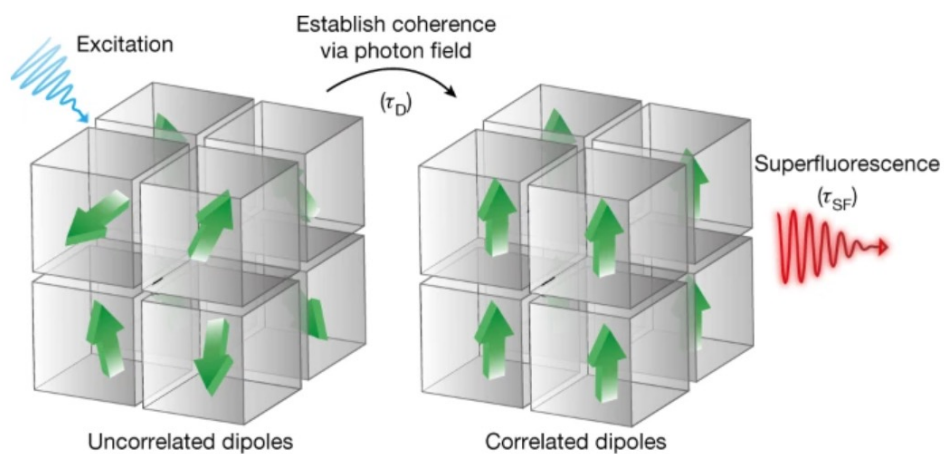


Random Lasing



Fingerprints

Superfluorescence



Biophysics, Biophotonics and Nanotechnology

Interdisciplinary science that addresses the complexity of biological systems through **quantitative experimental approaches**, particularly **based on light–matter interaction** with applications in nanotechnology.

Fundamental Research

- Protein aggregation (nucleation & kinetics)
- Phase separation (LLPS)
- Protein–membrane interactions (thermodynamics)
- Biomimetic soft matter compartments

Applied Research

- New Fluorescence spectroscopy & imaging approaches
- Protein-based micro/nano materials
- Lab-on-a-chip biosensors
- Photoactive biomaterials

Experimental Techniques

- Fluorescence Spectroscopy and Quantitative Microscopy
- Infrared Spectroscopy and Circular Dichroism
- Electron microscopies, Atomic Force Microscopy
- X-ray scattering at Large facilities



THESIS
ACTIVITIES



Hands-on
Experimental
work



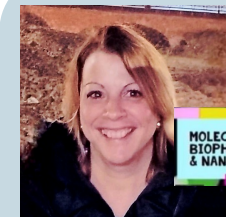
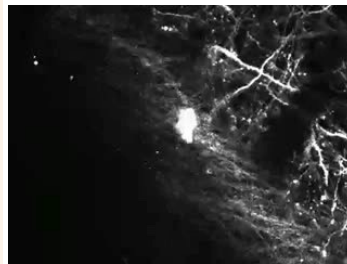
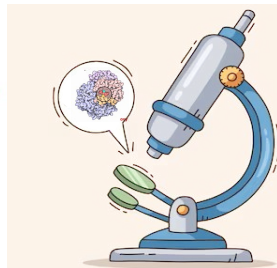
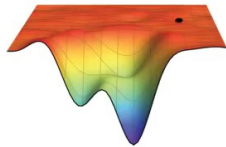
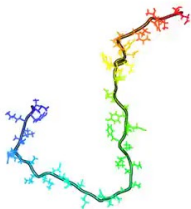
Optical
Techniques and
instrumentation



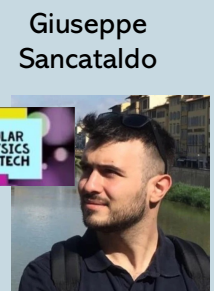
Sample
Preparation and
characterisation



Data Analysis



Valeria Vetri



Giuseppe
Sancataldo

MOLECULAR
BIOPHYSICS
& NANOTECH

Rivelatori di Radiazioni Ionizzanti ed Applicazioni

Gruppo di Ricerca



L. Abbene



F. Principato



A. Buttacavoli

Insegnamento

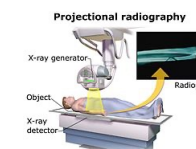
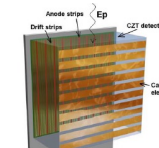
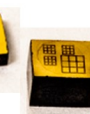
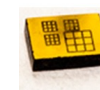
**RADIATION DETECTORS WITH LAB
(6 CFU)**

Docente: L. Abbene



**Tematiche
di Ricerca**

- **Sviluppo di Rivelatori a Semiconduttore per Radiazioni Ionizzanti (Materiali ed Elettronica)**
- **Strumentazione per Imaging X a Colori (Medicina Diagnostica, Farmaceutica, Food)**
- **Sistemi di Rivelazione X e Gamma per Applicazioni Astrofisiche e Nucleari**



Fisica astroparticellare e fisica delle particelle

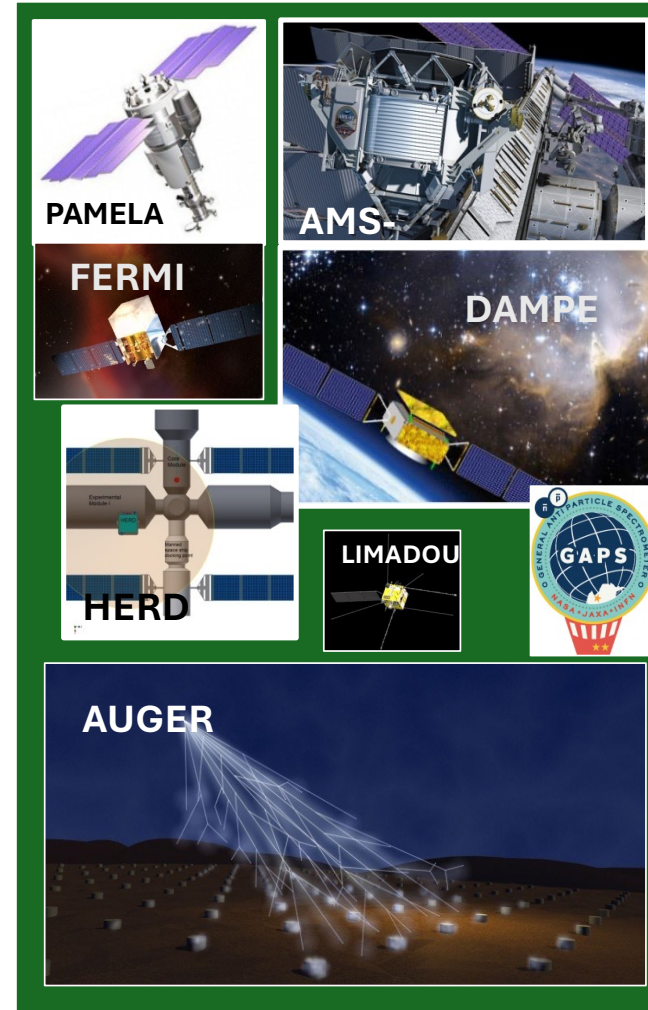


- Cosmic Rays:
Multimessenger astronomy
UHE cosmic rays (gamma and neutrino)
Underwater neutrino detection (KM3NET)
Cosmic Rays in Space (DAMPE, HERD)
- Particle Physics:
CERN (LHC Physics: CMS, ATLAS, LHCf)
FRASCATI (Plasma new generation accelerators)
Nu@FNAL (neutrino physics at FERMILAB)

Research activities with INFN

Rif.: Prof Giovanni Marsella
giovanni.marsella@unipa.it

Rif.: Dott.ssa Manuela Mallamaci
Manuela.mallamaci@unipa.it



Percorso magistrale

Suggerimento percorso magistrale

- I anno:
 - Mecc. Quant. Avanzata
 - Int. Radiazione-Materia
 - Fisica Statistica
 - Spettroscopia con Laboratorio
 - Teoria dei Campi
 - Computational Physics (o altro della categoria)
 - Astrofisica o General relativity
 - Materia a scelta
- Il anno
 - High Energy Astrophysics with Lab
 - Lab of Nuclear and Subnuclear Physics
 - Standard Model (attivo dall'aa. 2025/2026)
 - Lab of Astrophysics (o gauge theory)
 - Rivelatori di radiazioni con lab.

Suggerimento argomenti di tesi

1. *Analisi dati per lo studio indiretto dei raggi cosmici (Extensive Air Showers)*
2. *Analisi dati per lo studio diretto dei raggi cosmici (Rivelatori nello spazio)*
3. *Rivelatori di particelle per lo studio dei raggi cosmici*
4. *Sistemi DAQ per esperimenti di fisica delle particelle*
5. *Reti distribuite di sensori per applicazioni diverse*
6. *Fisica dei neutrini ad alta energia (KM3NET, DUNE)*

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