



Non-shared Courses

held by researchers of UniSalento or by researchers
of the CNR, IIT, INFN and INAF Institutes



Table A – Courses to be done by Professors and Researchers of the Department of Mathematics and Physics "Ennio De Giorgi", University of Salento, Lecce.

		Referent	Title	CFD (hours)	Indicative Schedule
1	Dr.	CASCIONE Mariafrancesca	<i>Mechanical forces in cell biology</i>	2 (10)	
2	Prof.	CORIANO Claudio	<i>Special topics in theoretical physics</i>	2 (10)	
3	Dr./Dr.	DE GIORGI Maria Luisa/LORUSSO Antonella	<i>Electronic Microscopy</i>	3 (15)	
4	Dr.	DE MATTEIS Valeria	<i>Nanostructured materials: physico-chemical properties and applications in different fields</i>	2 (10)	
5	Dr.	DE NUNZIO Giorgio	<i>Programming "Object oriented" in C ++</i>	4 (20)	
6	Prof.	DE PAOLIS Francesco	<i>Astrophysics of collapsed objects</i>	3 (15)	
7	Dr.	MORELLO Giovanni	<i>Physics of inorganic nanocrystals</i>	3 (15)	
8	Dr.	MORELLO Giovanni	<i>Polymer nanofibers (NFs) for advanced optical applications</i>	3 (15)	
9	Dr.	NUCITA Achille	<i>High Energy X-rays astrophysics and data analysis</i>	4 (20)	
10	Prof.	PERRONE Maria Rita	<i>Aerosol and radiative effects</i>	3 (15)	
11	Prof.	RINALDI Rosaria	<i>Molecular and biomolecular electronics</i>	2 (10)	
12	Dr.	ROMANO Salvatore	<i>Bioaerosol and its role in the spread of pandemics</i>	3 (15)	
13	Prof.	STRAFELLA Francesco	<i>Image Analysis</i>	6 (30)	
14	Prof.	VENTURA Andrea	<i>Hadron Collider Physics</i>	3 (15)	

Table B – Courses to be done by Professors and Researchers of other research institutions.

		Referent	Title	CFD (hours)	Indicative Schedule
1	Dr.	ACCORSI Gianluca CNR-NANOTEC	<i>Photophysics of artist's pigments</i>	2 (10)	
2	Dr.	ARIMA Valentina/ZIZZARI Alessandra CNR NANOTEC	<i>Current applications of microfluidic technology</i>	2 (10)	
3	Dr.	CIRACÌ Cristian IIT	<i>Advanced Plasmonics</i>	2 (10)	
4	Dr.	CUSCUNÀ Massimo CNR-NANOTEC	<i>Advances in micro- and nano-fabrication: techniques, applications & future prospects</i>	3 (15)	
5	Dr.	D'AGOSTINO Stefania CNR-NANOTEC & IIT	<i>Molecular Plasmonics</i>	2 (10)	
6	Dr.	DE GIORGI Milena CNR-NANOTEC	<i>Advanced Optical Techniques</i>	3 (15)	
7	Dr.	ELIA Davide INAF	<i>Acquisition Techniques for IR imaging and spectroscopy</i>	3 (15)	
8	Dr./Dr.	FABIANO Eduardo/DELLA SALA Fabio CNR-IMM & IIT	<i>Electronic structure methods for ground-state and optical properties</i>	3 (15)	
9	Dr.	FERRARA Francesco STMicroelectronics & CNR-NANOTEC	<i>Lab-on-a-Chip diagnostic devices: fabrication and industrial exploitation</i>	3 (15)	

Table B – Courses to be done by Professors and Researchers of other research institutions.

		Referent	Title	CFD (hours)	Indicative Schedule
10	Dr.	GERVASO Francesca CNR-NANOTEC	<i>Fabrication and characterization techniques of scaffolds for regenerative medicine</i>	3 (15)	
11	Dr.	GIOTTA Livia DiSTeBA	<i>Photo-induced phenomena in natural nano-systems</i>	2 (10)	
12	Dr.	GIOTTA Livia DiSTeBA	<i>Infrared spectroscopy for functional characterization of (bio)nano-systems</i>	2 (10)	
13	Dr.	LEPORATTI Stefano CNR-NANOTEC	<i>Nanomedicine and Techniques of Analysis at Nanoscale</i>	4 (20)	
14	Dr.	PALMA Giuseppe IBB-CNR (Naples)	<i>Physics of Magnetic Resonance Imaging</i>	2 (10)	
15	Dr.	POLITI Romolo INAF	<i>Cloud archive and computation. Digital planetology case</i>	3 (15)	
16	Dr.	TASSIELLI Gianfranco Dip. Fisica – Università degli Studi di Bari A. Moro	<i>Lepton Collider Physics</i>	3 (15)	
17	Dr.	TASSIELLI Gianfranco Dip. Fisica – Università degli Studi di Bari A. Moro	<i>Particle Physics Laboratory</i>	4 (20)	

A1. Mechanical forces in cell biology

Dr. CASCIONE Mariafrancesca
mariafrancesca.cascione@unisalento.it

TOPICS:

- Introduction to cell biology (structure, organization, and function of main cellular compartment).
- Why biomechanics is a crucial parameter in physiology and homeostasis?
- Fundaments of mechanics applied to biopolymers.
- Mechanics of cytoskeleton.
- Cell membrane mechanics.
- Force during cellular adhesion and spreading.
- Role of cellular mechanical properties in disease onset and progression.



A2. Special topics in theoretical physics

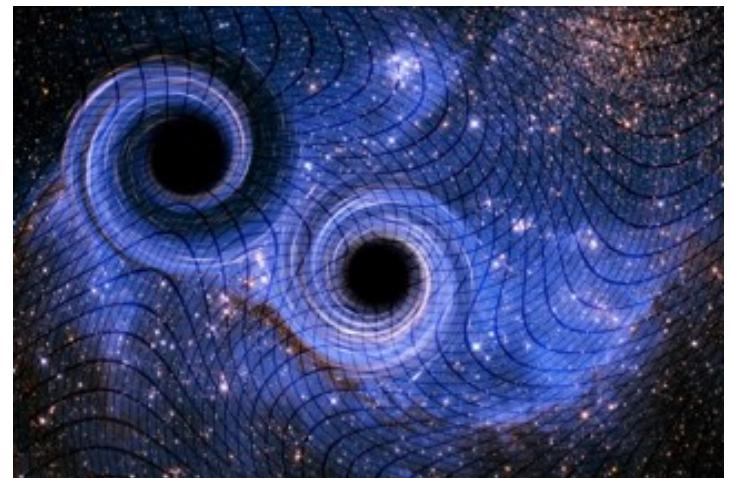
Prof. CORIANO' Claudio

claudio.coriano@le.infn.it

Quantum Gravity Elements (4 hours)

Axion Dark Matter (3 hours)

Standard Cosmological Model (3 hours)



A3. Electronic Microscopy

Dr. DE GIORGI Maria Luisa/Dr. LORUSSO Antonella
marialuisa.degiorgi@unisalento.it/antonella.lorusso@unisalento.it

Introduzione storica.

Microscopio elettronico a scansione (SEM). Componenti fondamentali di un microscopio elettronico (cannone elettronico; sorgenti elettroniche; lenti elettroniche; sistema di deflessione del fascio; sistema da vuoto).

Interazione fascio elettronico primario-campione e generazione di segnali. Elettroni secondari ed elettroni backscatterati. Sistemi di rivelazione e informazioni deducibili.

Generazione di raggi X. Raggi X caratteristici e microanalisi. Rivelatori di raggi X. Analisi qualitativa e quantitativa della composizione elementare (EDX- Energy-dispersive X-ray spectroscopy)

Microscopio elettronico in trasmissione (TEM) e differenze con il microscopio elettronico a scansione. Formazione delle immagini e della figura di diffrazione e loro interpretazione.

Tecniche analitiche associate alla microscopia in trasmissione: spettroscopia EDX ed EELS (Electron energy loss spectroscopy). Mappe chimiche.

Dimostrazione pratica di analisi morfologiche e compostionali con SEM+EDX su campioni degli dottorandi.

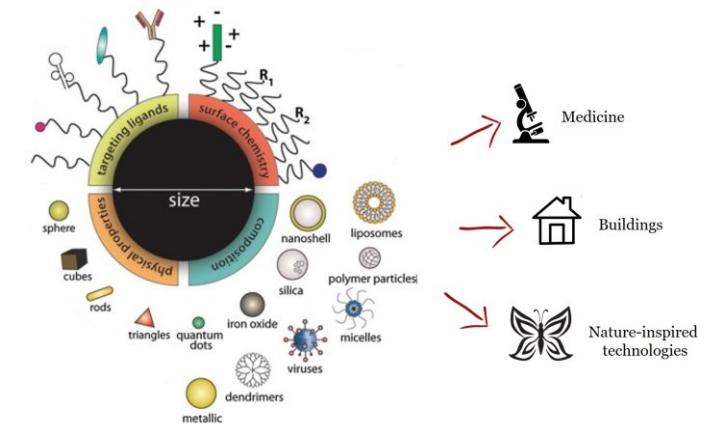


A4. Nanostructured materials: physico-chemical properties and applications in different fields

Dr. DE MATTEIS Valeria
valeria.dematteis@unisalento.it

TOPICS:

- Chemical and physical methods for synthesis of nanostructured materials;
- Physico-chemical properties of inorganic/ organic nanostructured materials and toxicology assessment in living organisms
- Application of nanostructured materials in medicine and diagnostics;
- Integration of nanostructured materials in buildings;
- Nature-inspired nanomaterials: from nature to technological applications.



A5. Programming "Object oriented" in C ++

Dr. DE NUNZIO Giorgio
giorgio.denunzio@unisalento.it

TOPICS:

- Introduzione: installazione dell'ambiente di lavoro, ciclo di produzione di un software, richiami sul linguaggio C (tipi di variabili, puntatori, funzioni, strutture di controllo, ricorsione, allocazione dinamica della memoria...). Differenze di base tra C e C++. Codifica su più file e uso di make.
- File I/O: differenze con il C; file binari e testuali.
- Passaggio di parametri per valore, tramite puntatore, e per riferimento.
- Librerie: object e shared
- Templates. Standard Template Library: std::vector<>, C-string e std::string, std::set, std::map...
- Object-Oriented Programming: struttura di una classe, encapsulation, costruttori/distruttori, overloading, overriding, inheritance...

A6. Astrophysics of collapsed objects

Prof. DE PAOLIS Francesco

francesco.depaolisi@unisalento.it

Program: Formations of the collapsed objects: last stages of stellar evolution. Supernovae. The physics of the gravitational collapse. Neutron star formation and cooling. Pulsars: observational properties and emission mechanisms. Recent discoveries about the braking index. Black holes: Schwarzschild, Reissner-Nordstron and Kerr solutions. Primordial black holes. Geodesics.

Based on the student interests, one CFD can be dedicated to the analysis of a number of topics such as: galactic dynamics (collisional and non-collisional gravitating systems); galaxy and galaxy cluster models; large scale structure formation; gravitational lensing physics.

A7. Physics of inorganic nanocrystals

Dr. MORELLO Giovanni
giovanni.morello@unisalento.it

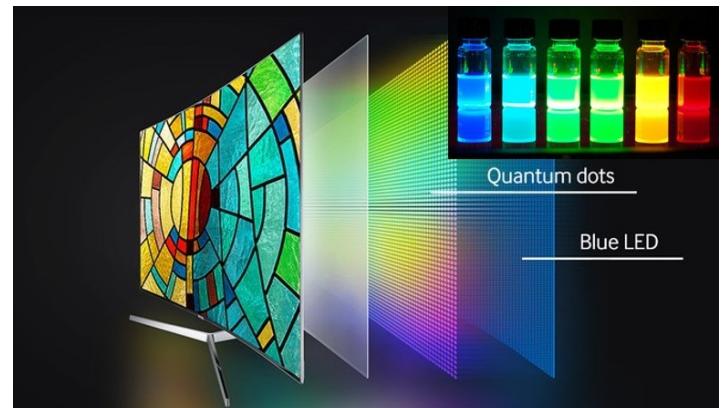
TOPICS:

1. Basic concepts

- Quantum effects in confined systems
- Excitons and electronic structure in semiconductor NCs
- A case study: CdSe NCs

2. Properties and characterization

- Relaxation paths in NCs
- Optical properties vs. the structural and physical parameters
- Advanced characterization methods: Time-resolved spectroscopy (single photon counting and streak camera methods); Single nanoparticle spectroscopy (principles of confocal microscopy, interferometric techniques)



A8. Polymer nanofibers (NFs) for advanced optical applications

Dr. MORELLO Giovanni
giovanni.morello@unisalento.it

TOPICS:

1. Basic concepts

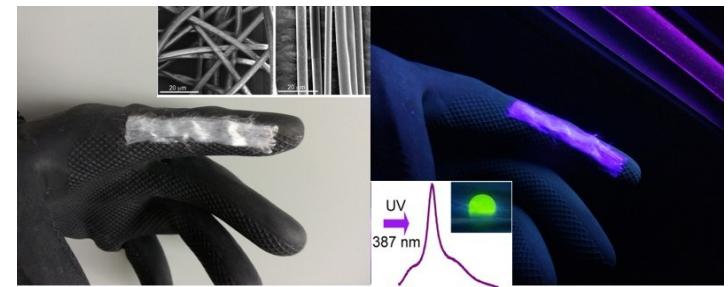
- Physics of polymers: from film to fibers

2. Fabrication and properties

- Mechanical and morphological properties of NFs
- Production methods: electrospinning (principles and technical features)
- Optical properties of light emitting NFs and their technological applications.

3. Optical spectroscopy methods

- Optical gain characterization (principles and realization)
- Time-resolved spectroscopy (single photon counting and streak camera experiments)
- Single NF spectroscopy: confocal spectroscopy and single NF waveguiding spectroscopy.



A9. High Energy X-rays astrophysics and data analysis

Dr. NUCITA Achille

achille.nucita@unisalento.it

TOPICS:

- X-ray astrophysics: energetics, time scales and fluxes. Accretion due to gravity and the Eddington limit. Atmospheric absorption. Experimental Tools of High Energy: proportional counters, Gas scintillation proportional counters, Scintillators, Microchannel plates, Microcalorimeters, CCDs
- Emission mechanisms: the radiation field, blackbody radiation, thermal Bremsstrahlung, single Particle Synchrotron Emissivity, thermal Synchrotron, Nonthermal Synchrotron, Compton scattering.
- Application in astrophysics
- Optics in the X-ray and UV regime. Wolter type telescopes.
- Data reduction and calibration. The event event files. Looking at the data, Selecting events of interest and Extracting analysis products. Calibration and Data analysis to extract images and spectra.
- Chandra, XMM-Newton and Swift telescopes: general views. The XMM-Newton telescope SAS system: installation of useful software and data analysis.
- Statistics in low count limit: the statistical underpinning of X-ray data analysis, Probability distributions. Parameter estimation and Confidence bounds
- Introduction to scripting

References:

Fulvio Melia, High energy astrophysics
Mario Vietri, Astrofisica delle alte energie
Arnaud, Handbook of X-ray Astronomy
Attwod, SOFT X-RAYS AND EXTREME ULTRAVIOLET RADIATION

Requirements (for the last part of the course):
knowledge of a programming language (C, Fortran, ILD, Python)

A10. Aerosol and radiative effects

Prof. PERRONE Maria Rita

mariarita.perrone@unisalento.it

Nell'ambito del corso di dottorato vengono definite ed illustrate le principali proprietà microfisiche ed ottiche dell'aerosol atmosferico, allo scopo di comprendere e valutare i suoi impatti sulla salute umana, l'ambiente ed i cambiamenti climatici. Vengono altresì trattate le principali tecniche di campionamento "in situ" e con monitoraggio remoto.

Pertanto i principali temi trattati sono:

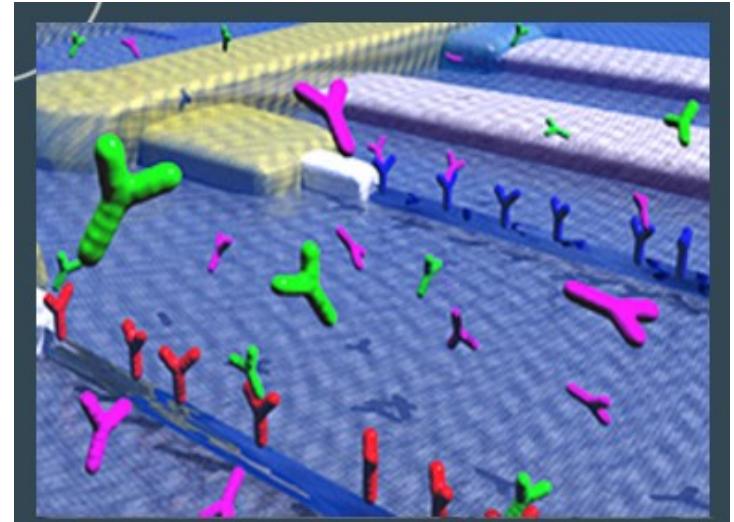
- sorgenti naturali ed antropiche dell'aerosol atmosferico e tecniche di campionamento;
- aerosol primario e secondario, diametro geometrico ed aerodinamico, distribuzioni dimensionali in numero e volume;
- composizione chimica dell'aerosol;
- proprietà ottiche delle particelle di aerosol;
- processi di diffusione ed assorbimento e legge dell'estinzione di Beer Bougeuer Lambert;
- flussi radiativi, variazioni di flusso radiativo attraverso uno strato di particelle, bilancio radiativo terrestre;
- applicazioni del forzante radiativo a casi specifici (e.g. eruzione vulcanica, eclissi di sole).

A11. Molecular and biomolecular electronics

Prof. RINALDI Rosaria
rosaria.rinaldi@unisalento.it

TOPICS:

- Motivation and concepts
- Formal definition of molecular electronics and a little bit of history
- Moletronics nanodevices: fabrication and testing
- The amazing world of bio-inspired computing
- Biomolecular nanodevices: devices based on DNA and proteins
- Molecular Quantum Cellular Automata
- DNA computation
- Conclusions and outlook



Prof. Mark Reed group, Yale University

A12. *Bioaerosol and its role in the spread of pandemic*

Dr. ROMANO Salvatore
salvatore.romano@unisalento.it

TOPICS:

- Introduzione sul particolato atmosferico: classificazione, sorgenti ed effetti sul clima, sull'ambiente e sulla salute (3 ore)
- La componente biogenica del particolato atmosferico: sorgenti, effetti e possibile ruolo nella diffusione di pandemie (3 ore)
- Tecniche di monitoraggio del particolato atmosferico e della sua componente biogenica (3 ore)-Tecniche di analisi statistica e bioinformatica (3 ore)
- Caratterizzazione delle comunità batteriche e virali in campioni di particolato atmosferico (3 ore)

A13. *Image Analysis*

Prof. STRAFELLA Francesco

francesco.strafella@unisalento.it

TOPICS:

- Trasformate di Fourier
- Campionamento e ricostruzione
- Trasformate di wavelet
- Analisi delle componenti principali (PCA)
- Analisi delle componenti indipendenti (ICA)

A14. Hadron Collider Physics

Prof. VENTURA ANDREA

andrea.ventura@unisalento.it

Particle accelerators and main physics quantities related. Elements of magnetic optics. Comparison between fixed target and collider experiments. Comparison between hadronic and electronic colliders.

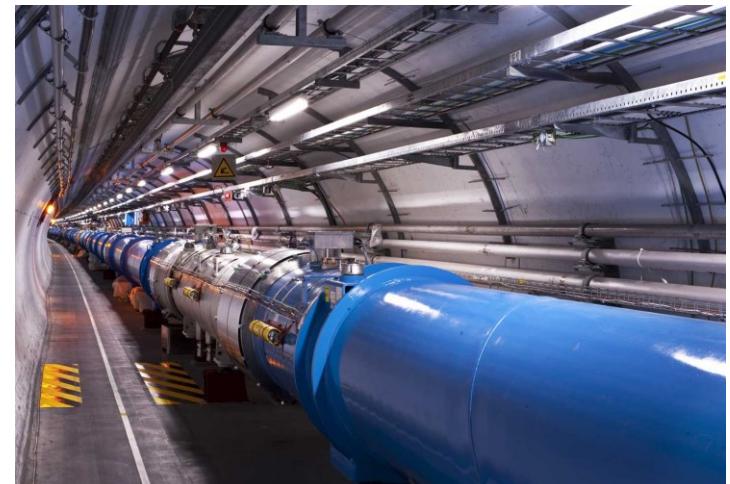
History and examples of hadronic colliders: ISR, SPS and SppS at CERN, HERA in DESY, RHIC. Modern colliders (Tevatron and LHC) and their main hadronic experiments. Perspectives for future colliders.

CDF and D0 experiments at Tevatron. QCD processes, hadronization, Jet Energy Scale. Processes of production and decay of the Tevatron top quark. Identification of the top quark and mass and cross section measurements at the Tevatron.

The Large Hadron Collider (LHC) and the ATLAS experiment. Inner Detector, Calorimeters and Muon detector systems. Reconstructions of events at ATLAS: from cosmic rays to the “rediscovery” of the W and Z and the discovery of the Higgs boson. Trigger and DAQ system.

Cross sections of processes at the LHC and the Tevatron. Processes with jets. Measurements of masses and cross sections of W and Z at CDF and ATLAS. Top quark production at the LHC and comparison with the Tevatron. Identification of events with top pairs. B-tagging at ATLAS. Production of single tops. Mass measurements of the top at LHC and comparison with Tevatron. Asymmetry and possible FCNC decays of the top.

New Physics searches beyond the Standard Model at the LHC. Exotic decays of the top quark. Supersymmetric models without and with violation of R-parity: selections and techniques of background reduction, inclusive and exclusive searches. Resonance searches at high masses: dileptons, di-jets, diphotons.



B1. Photophysics of artist's pigments

Dr. ACCORSI Gianluca
gianluca.accorsi@nanotec.cnr.it

TOPICS:

- Photophysics basics (light-matter interactions and relative photoinduced processes)
- Application fields
- Role and advantages of photophysics in works of art
- Case studies (Egyptian Blue, Indian Yellow, Manganese Blue, Tyrian purple)
- Experimental techniques (In lab)



B2. Current applications of microfluidic technology

Dr. ARIMA Valentina/Dr. ZIZZARI Alessandra

valentina.arima@nanotec.cnr.it/alessandra.zizzari@nanotec.cnr.it

TOPICS:

- Fundamentals of microfluidics (2h)
- Microfluidic applications for chemistry (2h)
- Microfluidic applications for biosensing (2h)
- Microfluidics for lab-on-a-chip applications (2h)
- Microfluidics for organ-on-a-chip applications (2h)

B3. Advanced Plasmonics

Dr. CIRACI' Cristian
cristian.ciraci@iit.it

TOPICS:

1. Electromagnetics of metals

- Dielectric function of the free electron gas
- Surface plasmon polaritons

2. Beyond classical electrodynamics

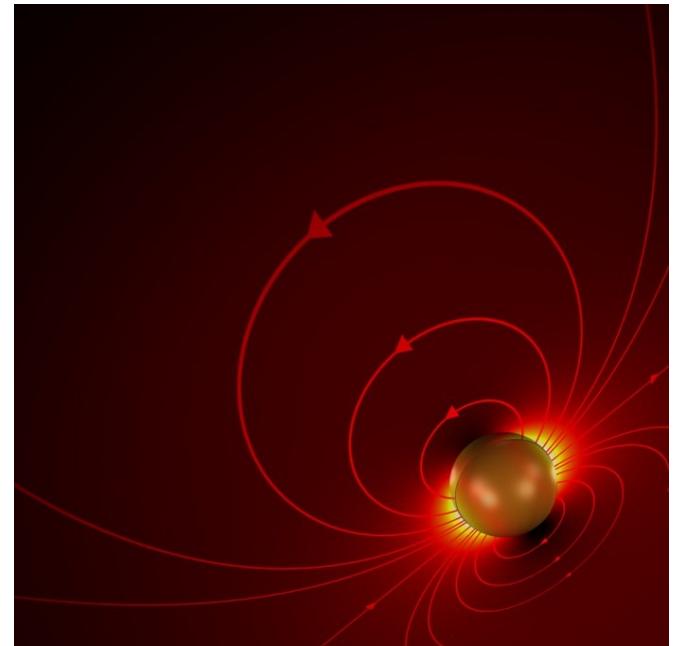
- Spatial dispersion vs nonlocal response
- Thomas-Fermi approximation
- Additional boundary conditions
- Quantum hydrodynamic theory

3. Nonlinear optics

- Nonlinear susceptibility
- Harmonic generation
- Nonlinear plasmonics

4. Numerical methods for EM

- Finite-difference method
- Finite-elements method
- Application to EM



B4. Advances in micro- and nano-fabrication: techniques, applications & future prospects

Dr. CUSCUNA' Massimo
massimo.cuscuna@nanotec.cnr.it

Course Objective:

The objective of the present course is to provide students with a glimpse into the micro- and nano- fabrication techniques along with their applications.

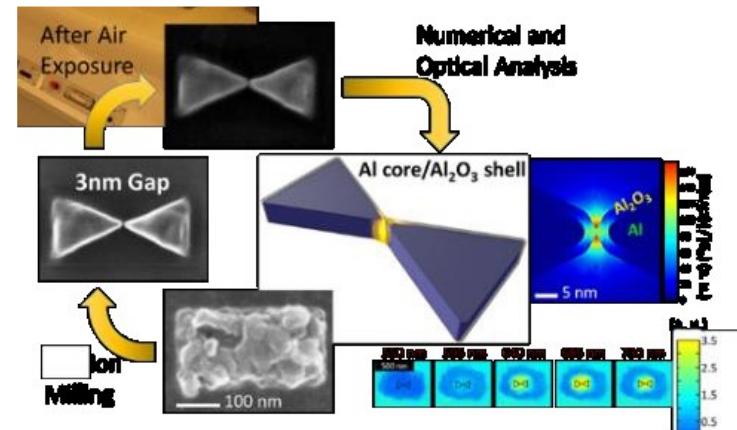
This course consists of two parts: "Micro- and Nano-fabrication techniques" deals with the fabrication of structures at micro and nanoscale, while "Microscopy" concerns the visualization of such small features.

We start with a general overview of micro/nanotechnology, explaining why the properties of materials are so different at the micro/nanoscale compared to the macroscale. The difference between top- down and bottom-up fabrication is explained and the ultimate industrial fabrication process (CMOS) is outlined, including the technological issues related to further scaling according to Moore's Law. We introduce the need of cleanroom environment for what concerns fabrication processes.

Subsequently, advanced material deposition (chemical vapor deposition, atomic layer deposition), etching (wet and dry) and lithography concepts are illustrated; an overview of promising nanopatterning techniques, such as electron and ion beam-based approaches is introduced. We also discuss bottom-up processes such as the chemical growth of nanostructures like carbon nanotubes, silicon nanowires. State-of-the-art applications in the field of electronics, photonics and biosensing exploiting micro- and nano-fabrication techniques are shown.

The second part of the course introduces general microscopy concepts such as magnification, resolution, depth of field and contrast, it is discussed how image formation is achieved in optical and electron microscopy. The latter is mainly addressed because enabling visualization of nanoscale structures.

The lab session involves lithography and scanning electron microscope imaging.



B5. Molecular Plasmonics

Dr. D'AGOSTINO Stefania
stefania.dagostino@iit.it

TOPICS:

1. Metal-Molecule Interactions in the Weak Coupling Regime

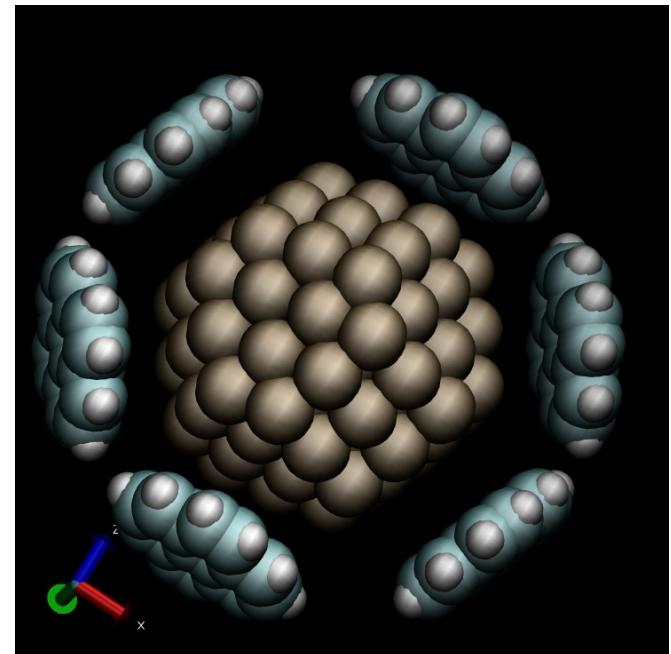
- The Localized Surface Plasmons (LSPs) in Classical Electromagnetism
- Dipole Decay Dynamics Engineering in the Classical Framework

2. Metal-Molecule Interactions in the Strong Coupling Regime

- The Two-Coupled Harmonic Oscillators Paradigm
- The Semi-Classical and Fully Quantum Mechanical Frameworks

3. Metal-Molecule Interactions in the Tunneling Regime

- Basics of Ground-state and Time-Dependent DFT
- DFT-based Approximations for Plasmonic Systems



B6. Advanced Optical Techniques

Dr. DE GIORGI Milena
milena.degiorgi@nanotec.cnr.it

TOPICS:

1. Introduction to standard optical spectroscopy techniques.
2. Optical properties of different materials from semiconductor to hybrid to organic structures.
3. Polarization spectroscopy.
4. Introduction to more advanced optical spectroscopy techniques:
 - Confocal microscopy for high spatial resolution experiments;
 - Time-resolved spectroscopy for study of carrier dynamics;
 - Femtosecond Pump-Probe Transient Absorption Spectroscopy for study;
5. Temporal and spatial coherence.
6. Intensity correlation experiments.

B7. Acquisition Techniques for IR imaging and spectroscopy

Dr. ELIA Davide
davide.elia@inaf.it

TOPICS:

- Propaedeutic topics: Fourier transform, Convolution.
- Observability from the ground as a function of wavelength
- Radiative transfer
- Molecular clouds
- Rotational transitions of molecules: biatomic and polyatomic cases.
- Integrated line intensity maps
- Vibrational transitions of molecules: biatomic and polyatomic cases.
- Rotational spectra in the near infrared
- Raman spectroscopy
- Scheme of a spectrometer
- Illuminating source
- Collimator
- Light dispersion
- Prism
- Interference and diffraction
- Diffraction grating
- Filters
- Fabry-Pérot interferometer
- Generalities on detectors for Infrared
- Pyroelectric detector, thermocouple, bolometer
- Semiconductors, photodiode
- Michelson interferometer, Fourier transform spectroscopy
- Heterodyne
- Acousto-optical detectors
- Infrared imaging: CCD, CMOS, thermal camera
- Bolometer arrays
- False colour images
- Interferometry
- Astronomical interferometers for far infrared and sub-mm
- Polarimetry
- Brewster and Malus laws
- Polarimeters

B8. Electronic structure methods for ground-state and optical properties

Dr. FABIANO Eduardo/DELLA SALA Fabio
eduardo.fabiano@cnr.it/@fabio.dellasala@unisalento.it

TOPICS:

1. Introduction to electronic structure theory

- The electronic problem,
- Spin configurations and spin projection
- Born-Oppenheimer approximation and adiabatic coupling

2. Ab initio methods

- The Hartree-Fock method
- Basis sets and basis set extrapolation
- Roosman and Pople-Nesbet equations
- Post Hartree-Fock correlation methods: MP2 and CI

3. Density functional theory

- Density matrices and electron density, Thomas-Fermi theory
- Basics of ground-state DFT, Hohenberg-Kohn theorems, Levy constrained search, Kohn-Sham method
- Functionals and functional derivatives
- The exchange-correlation functional, XC hole, adiabatic connection
- Exchange-correlation approximations

4. Optical properties

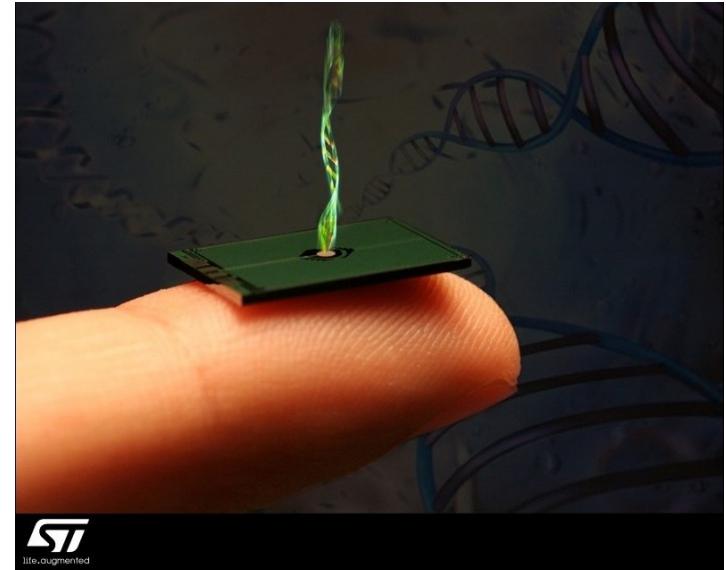
- Linear and Non-linear Operators, Volterra Series
- Many-Body Linear Response, Polarizability, Sum rules
- Optical properties of finite and extended systems: Gap and Excitons
- Time-Dependent Density Functional Theory for finite and extended systems
- Many-body and RPA Dielectric functions
- Charge-transfer and Local-fields effects

B9. Lab-on-a-Chip diagnostic devices: fabrication and industrial exploitation

Dr. FERRARA Francesco
francesco.ferrara@st.com

TOPICS:

During lessons, industrial exploitation of medical devices will be described. Part of the course will be spent to introduce basic concept of molecular biology to better understand principal application of lab-on-a-chip and basic techniques for electronic and plastic chip fabrication will be illustrated. Special emphasis will be given to the intellectual properties strategies to protect invention ad how it is possible to use IP in industrial development.



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B10. Fabrication and characterization techniques of scaffolds for regenerative medicine

Dr. GERVASO Francesca
francesca.gervaso@nanotec.cnr.it

Many biological tissues are unable to regenerate when injured, but only to reproduce a so-called reparative tissue that does not have the same properties as native tissue. One of the fundamental purposes of Tissue Engineering or Regenerative Medicine is to "build" in the laboratory, biological substitutes for damaged or malfunctioning tissues and organs with the final aim of implanting them in patients. The main objective of this course is to provide students with the basic knowledge and skills for understanding the technologies/methodologies currently used for tissue regeneration, including:

- the 'intelligent' use of biomaterials and biopolymers for the development of micro- and nano-structured matrices (i.e. scaffolds) capable of inducing tissue regeneration;
- the use of combined therapies, based on the use of suitable cellular components, molecular regulators and scaffolds;
- the in-depth study of cell-matrix interactions.

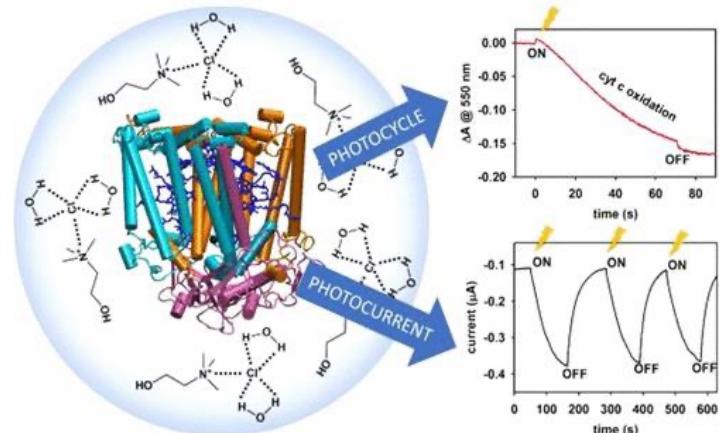
- *Tissue Engineering: Introduction*
- *Cell-material interactions: Extra-Cellular Matrix (ECM)*
- *Cell-material interactions: Unit Cell Processes (UCPs)*
- *Scaffold: functions, properties, design variables*
- *Scaffold: fabrication techniques (I)*
- *Scaffold: fabrication techniques (II)*
- *Scaffold: characterization techniques (I)*
- *Scaffold: characterization techniques (II)*
- *Hydrogel: biomedical applications*
- *Surface modifications: plasma treatments for cell culture*
- *Tissue Engineering: cells*
- *Bioreactors*
- *Tissue Engineering: regulators and drug delivery*
- *Biomechanics*
- *Tissue Engineering Application: bone and cartilage regeneration*
- *Tissue Engineering Application: tendon and ligament regeneration*

B11. Photo-induced phenomena in natural nano- systems

Dr. GIOTTA Livia

livia.giotta@unisalento.it

The lectures will provide a short overview on basic concepts of chemical thermodynamics and chemical kinetics relevant to energy conversion processes in biological systems (Gibbs free energy, exergonic and endergonic processes, coupled reactions, order of reaction and molecularity, first- order processes, competitive reactions and kinetic control, Marcus theory). The concepts will be applied to the physico-chemical description of light reactions of bacterial photosynthesis. Some physico-chemical techniques for the investigation of photo-induced electron-transfer processes will be presented. Finally, some applications of natural photosynthetic systems in the field of functional nano-hybrid materials will be introduced and discussed.

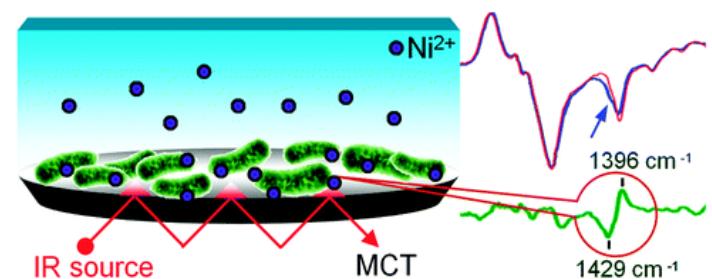


B12. Infrared spectroscopy for functional characterization of (bio)nano-systems

Dr. GIOTTA Livia

livia.giotta@unisalento.it

The lectures will provide the fundamentals of vibrational spectroscopy with a focus on the application of mid-infrared absorption spectroscopy for the functional investigation of complex systems. An overview of in situ-techniques based on Attenuated Total Reflectance (ATR) modality will be presented. Practical activities will be proposed, allowing PhD students to get familiar with FTIR techniques and to experience the potential of reaction-induced ATR- FTIR difference spectroscopy (light-induced, perfusion-induced, electrochemically-induced) to the investigation of complex systems functioning.



B13. Nanomedicine and Techniques of Analysis at Nanoscale

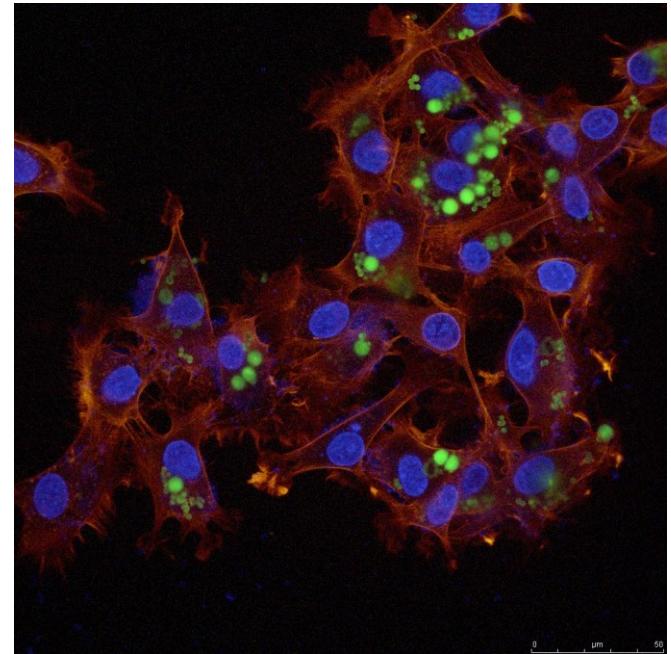
Dr. LEPORATTI Stefano
stefano.leporatti@nanotec.cnr.it

TOPICS:

- Nanomedicine (4 hours)
- Drug Delivery Systems (DDS) (4 hours)
- Techniques of Bio-funzionalization and Synthesis of Nano e Micro Colloidal Particles (2 hours)
- Atomic Force Microscopy (4 Hours)
- Confocal Microscopy (4 Hours)
- Fluorescence Microscopy (2 hours)

Lessons: Building G, Second Floor, Room Marie Curie, @ CNR Nanotec, Tuesday and Friday 15.00-17.00 (May-June) or on-line by Microsoft Teams

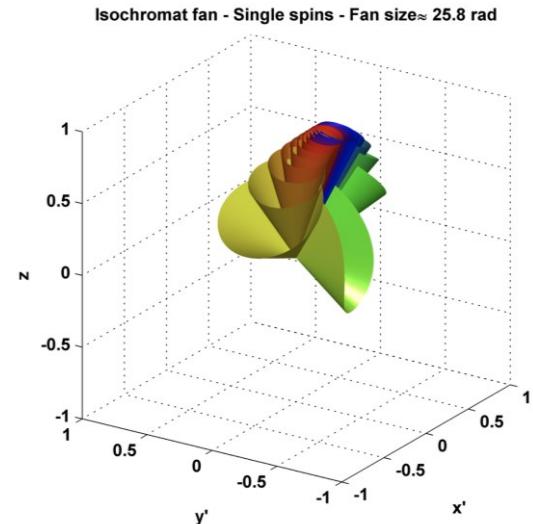
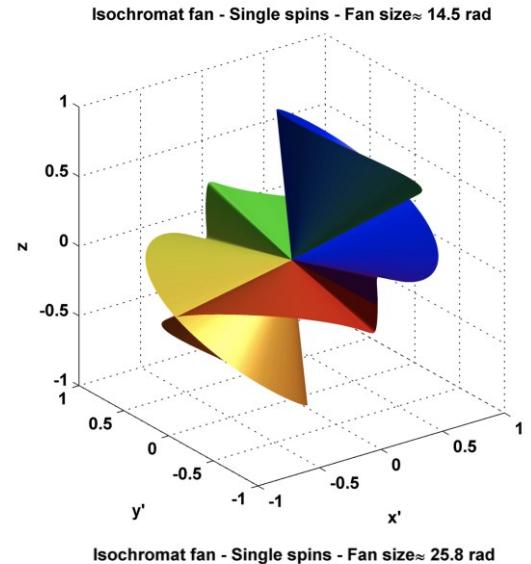
Examination: A seminar on a free Thematic of course (at the end of the course)



B14. Physics of Magnetic Resonance Imaging

Dr. PALMA Giuseppe
giuseppe.palma@ibb.cnr.it

- Nuclear Magnetic Resonance (nuclear magnetic moments; magnetic resonance; thermal equilibrium; relaxation; Bloch equation; free induction decay, spin echo, inversion recovery);
- Principles of Magnetic Resonance Imaging (selective RF-pulses; k-space);
- Spatial encoding (2-3D sequences; phase encoding schemes; segmented k-space; echo-planar imaging; radial imaging; multi-slice sequences; chemical shift imaging);
- MRI contrasts (Spoiled gradient echo; spin echo; inversion recovery; susceptibility-weighted imaging; fat suppression schemes; diffusion imaging; flow-encoding and phase contrast MRI; gating; magnetization transfer; contrast enhancement; perfusion imaging; BOLD and functional MRI; quantitative MRI);
- Extended phase diagram.



B15. Cloud archive and computation. Digital planetology case

Dr. POLITI Romolo
romolo.politi@inaf.it

Nel corso si descriveranno i vari tipi di approccio al calcolo e di archiviazione dei dati, mostrando il percorso che ha portato al *cloud* come risposta alle varie problematiche. Verrà utilizzata l'Astroinformatica e la Planetologia Digitale come applicazione a tale approccio, poiché questa richiede tipologie di calcolo molto diverse tra loro, che vanno dall'alto “*throughput*”, flusso di dati in ingresso e/o in uscita, all'alto numero di “*flops*”, operazioni in virgola mobile al secondo. Inoltre, i dati manipolati in tale applicazione hanno un volume molto elevato e sono profondamente eterogenei, sia dal punto di vista dell'archiviazione che dal punto divista della natura del fenomeno che descrivono, e rappresentano un buon paradigma per analizzare l'approccio al big data ed il loro sfruttamento con questa tipologia di calcolo.

Durante il corso si esploreranno i tre cardini del calcolo, rappresentazione, manipolazione e visualizzazione del dato.

La rappresentazione del dato è quella branca delle scienze dell'informazione, e del corso che si propone, che studia come il dato viene archiviato (formato elettronico) e come viene descritto (metadato associato). Durante il corso verranno esplorati i differenti e più diffusi formati. Verrà esplorato con maggiore dettaglio il formato PDS4, usato in planetologia, al fine di comprendere la filosofia dell'*LTP*, *Long Term Preservation*.

La manipolazione del dato è il ramo in cui si studia il problema che si vuole affrontare e la tipologia dei dati che devono essere utilizzati al fine di determinare l'approccio informatico (sequenziale parallelo, uso GPU etc.) l'algoritmo e linguaggio più idoneo.

1. L'evoluzione del calcolo;
2. Definizione di dato e metadato;
3. Sistemi di archiviazione dei dati e dei metadati;
4. I database relazionali (SQL) e non relazionali (MongoDB);
5. Architettura Cloud;
6. I dati nel Cloud;
7. Il calcolo nel Cloud;
8. Virtualizzazione e Container
9. Microservices e DevOps
10. La visualizzazione del dato.
11. Realtà aumentata e VR.
12. Fondamenti di Python orientato agli oggetti.

Sempre nell'ambito della manipolazione, di particolare interesse è *l'housing* del software, che nel mondo del cloud ha differenti soluzioni, dal *PaaS* (*Platform as a Service*) al *SaaS* (*Software as a Service*). **La rappresentazione del dato** studia come il dato deve essere rappresentato al fine di essere compreso nella sua interezza e nei suoi vari aspetti. La rappresentazione tramite uno schema cartesiano rappresenta solo il caso più semplice di rappresentazione. Nel caso di dato multi-variabile sono estremamente interessanti le rappresentazioni interattive multidimensionali o il *layering*, cioè la sovrapposizione di più tipologie di dato. Di particolare interesse, sia per l'aspetto accattivante che per le possibilità di analisi, sono le nuove tecniche di rappresentazione in realtà aumentata ed in realtà immersiva.

Durante il corso verranno esplorati i fondamenti del **linguaggio Python**, al fine di applicare i concetti discussi a casi studio reali.

Il corso proposto può essere così schematizzato: