



EUPEN's 13<sup>th</sup> General Forum

Cyprus 28-30 August 2011

# Modern Physics Laboratories and NANO for YOU<sup>th</sup>: Quantum Physics at work

*Nano bottom up/top down across Physics curricula*

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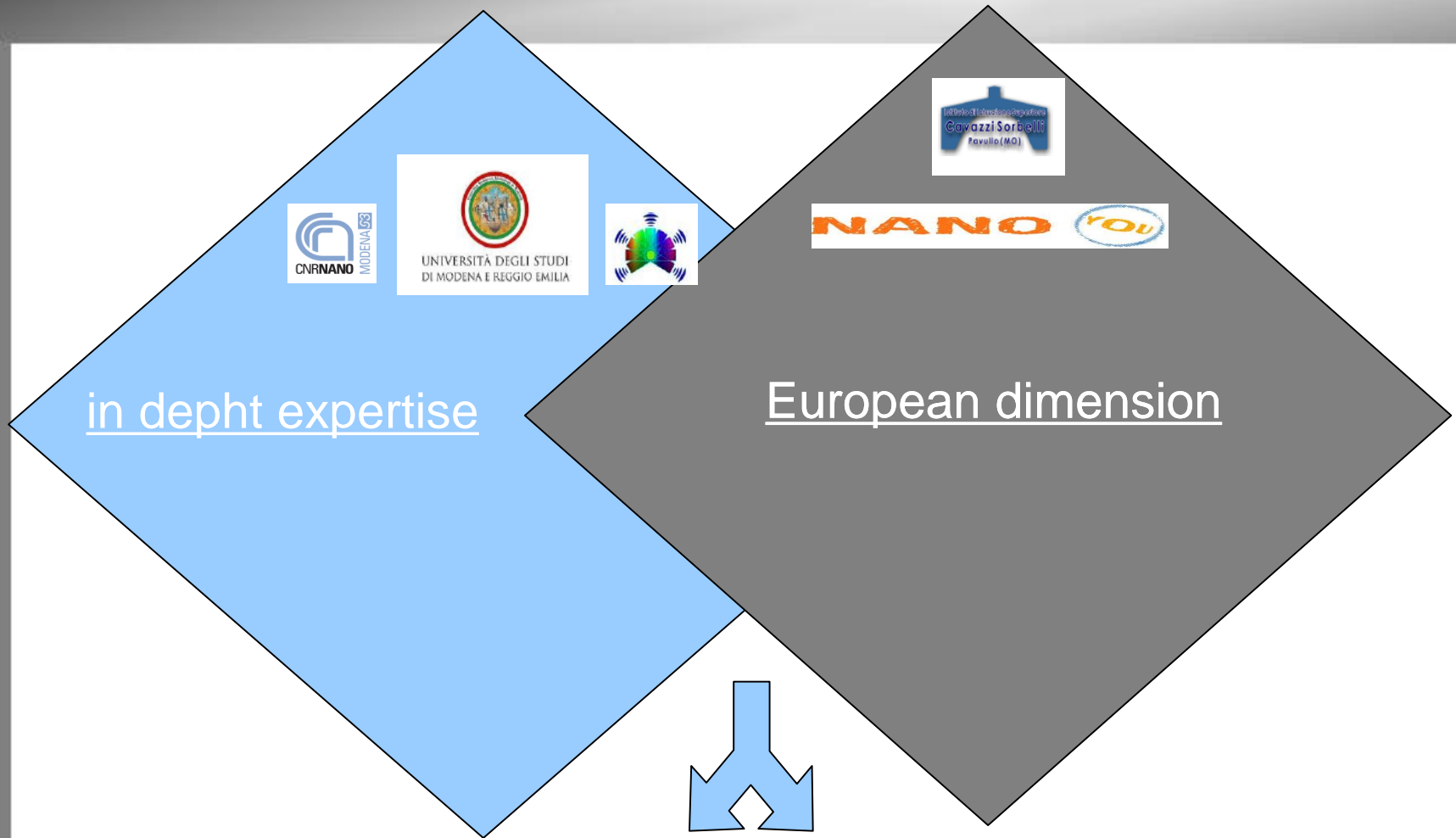
# Outline

- Modern Physics is too often neglected in school or approached as something **abstract** and weird although conceptually fascinating.
- Nanosciences are an ideal playground to
  - ✓ engage students in **frontier research**
  - ✓ introduce the basics of quantum mechanics at high school level with an **hands on** and intrinsically **interdisciplinary** approach,
  - ✓ link **fundamental science** both to actual **technology** and to feasible one (bioelectronics, quantum computers...)
- In order to reach this ambitious goal **teachers professional development** is a fundamental issue.

- **Modern Physics labs @ UniMoRe**
- **Nanoyou**
- **Further action**



# Bringing together education and research



- Bringing cutting edge research into the classroom,
- Integrating Nanoscience and Nanotechnology in Science and Physics high school curricula

- Quite new in EU (see USA)
- Teachers training +support

Encouraging scientific research

# Bringing together education and research



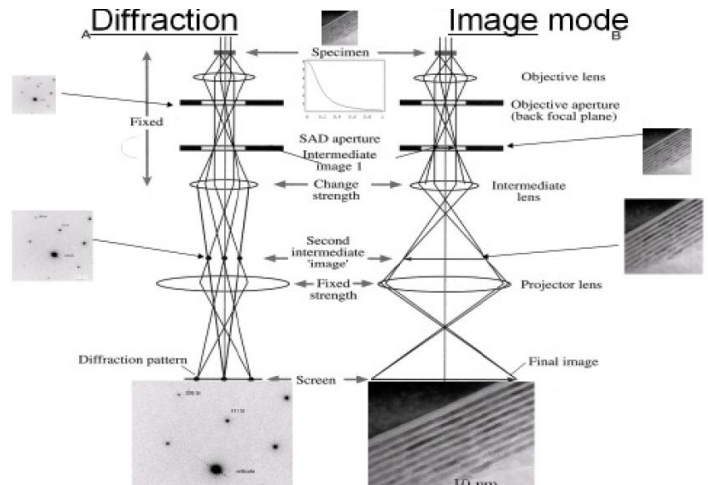
## Modern Physics Labs

- From researchers' personal experience
  - Quantum physics at work
  - Basic science, investigation techniques
  - Sophisticated instruments
- Visits to the Dep. and research labs
- Pre/post activities at school



**2007-** students stages and  
first teachers training  
[www.physicscom.unimore.it](http://www.physicscom.unimore.it)

# Modern Physics Laboratories- From optics to TEM

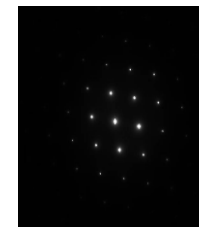
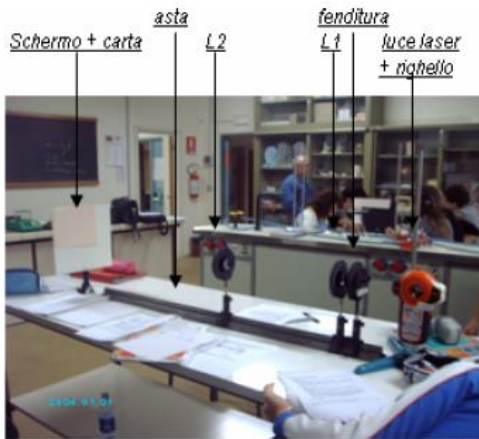


Nanosciences use a whole range of tools and techniques to study and manipulate matter at the nanoscale.

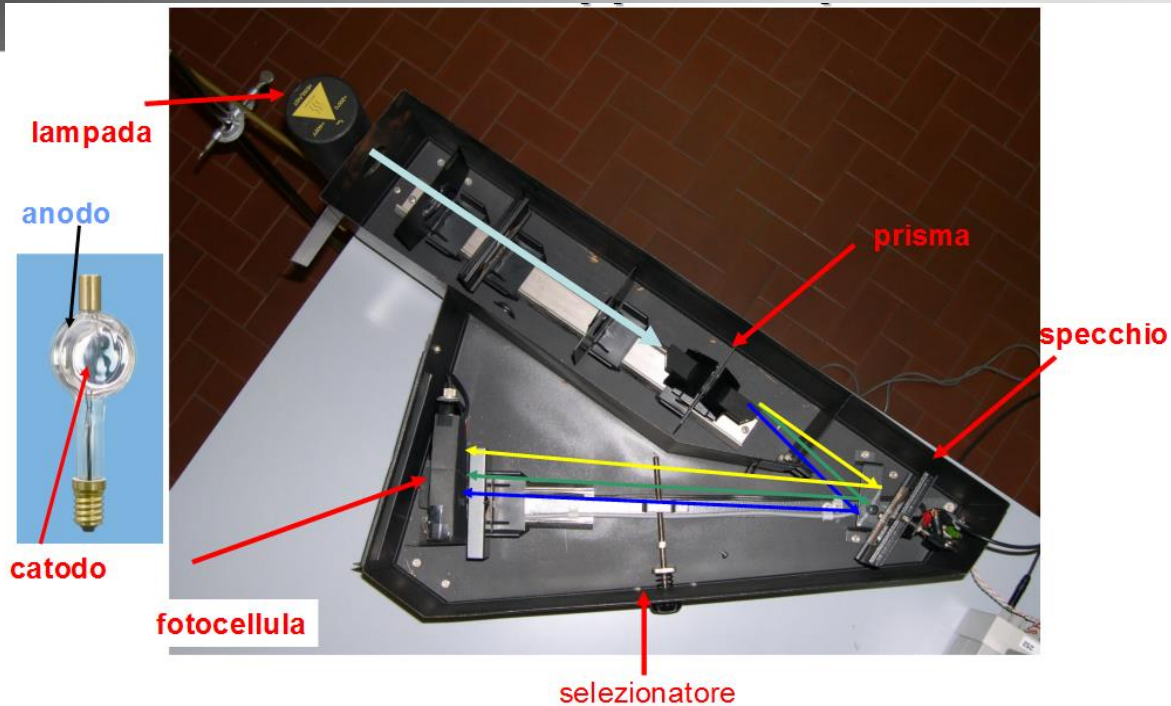
Electron microscopy is one of them. How it works can be better understood thanks to a parallel module leading from optics to TEM.

Reflecting on light dual nature students are naturally brought to recognize such duality in matter too.

Diffraction is then used in classroom as an effective tool to see the invisible and measure incredibly small sized details: from hair thickness to printed electronics.



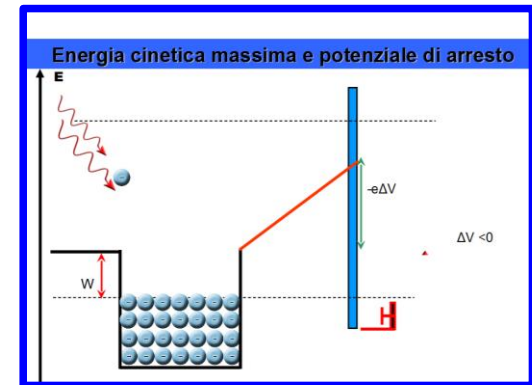
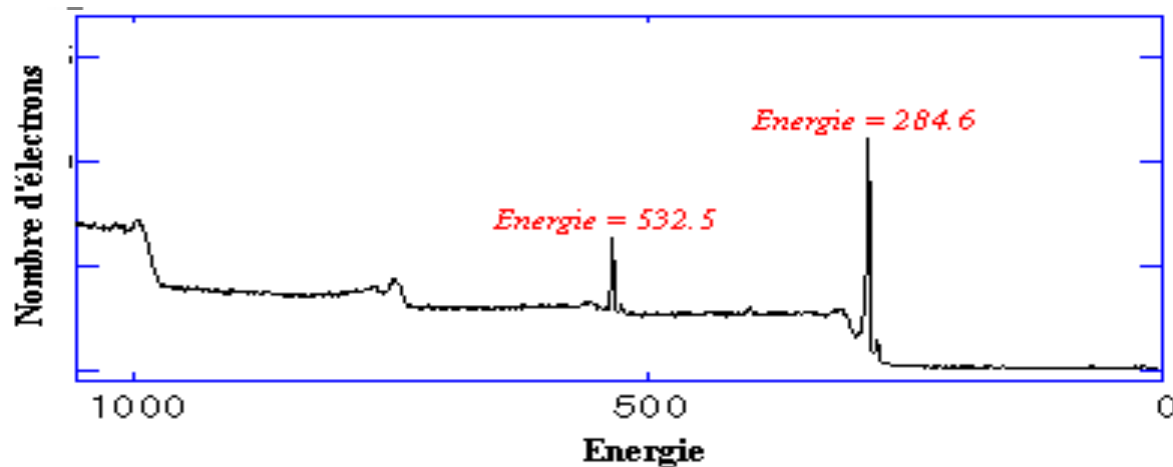
# Modern Physics Laboratories- From photoelectric effect to photoemission spectroscopy



Experimenting with photoelectric effect students are led to understand some basics of Quantum Mechanics such as **light and matter interaction, energy quantization, Planck's constant**.

Further on they are shown how such theoretical principles can be applied to the investigation of new materials in photoemission spectroscopy.

Atomic spectra can be read as elements fingerprints.



# Bringing together education and research



## EU Project FP7-NANOYOU

- Hands on activities in school labs
- Integrating interdisciplinary research with traditional science concepts
- Great interest for applications
- Attention for ethical and societal issues
- Students working as researchers in testing new materials
- Designing more experiments

**2010** - inspired by PLS experience Liceo Sorbelli joins in NANOYOU as pilot school

- Focused on **divulging** and **communicating** nanotechnologies in **school** (NANO for YOUth)
- Age **11-13/ 14-18**
- Funded by the European Commission (**FP7**)
- A joined effort of **European Schoolnet**, research centres, + ORT Israel
- Lasting : **2009-2011** → Nanochannel (now running)
- **48 pilot schools** across EU with cascade dissemination





- Free download of [materials and resources](#) at : [www.nanoyou.eu](http://www.nanoyou.eu)
- Editable under the Creative Commons Licence

**Videos**

**Posters**

**PPT presentations**

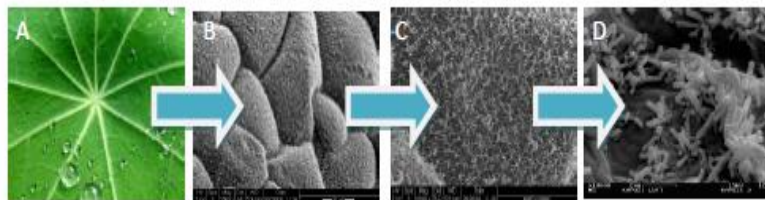
**Background readings**

**Experimental activities**

**Activities on legal, ethical and societal issues**

**Travelling Exhibition (Lyon,Paris,....)**

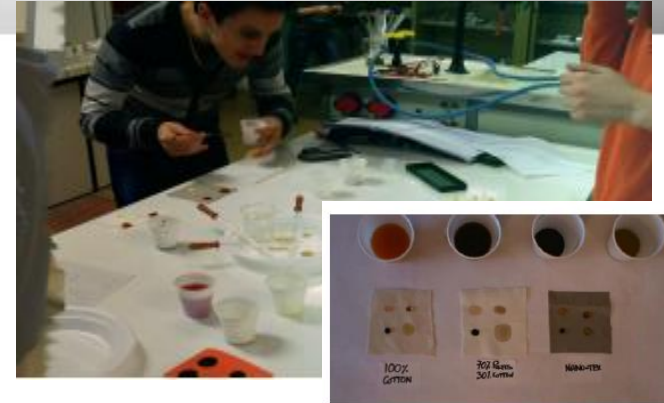
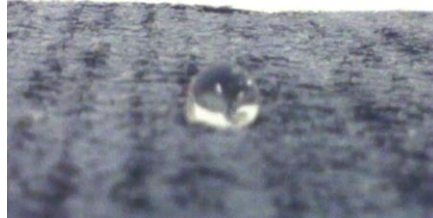
**Links collection to further nano resources**



- In English + students materials in a plurality of european languages
- Support from pilot schools through the [on line community](#)

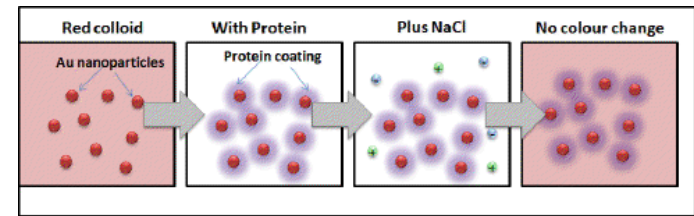
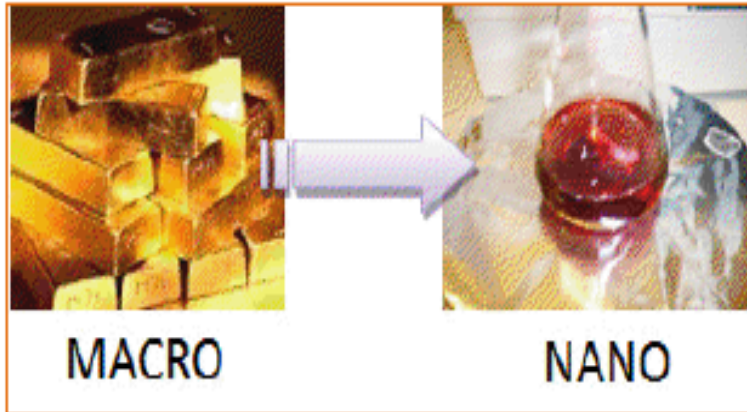
<http://blog.eun.org/nanoyou/> → REGISTER !

# Experiments



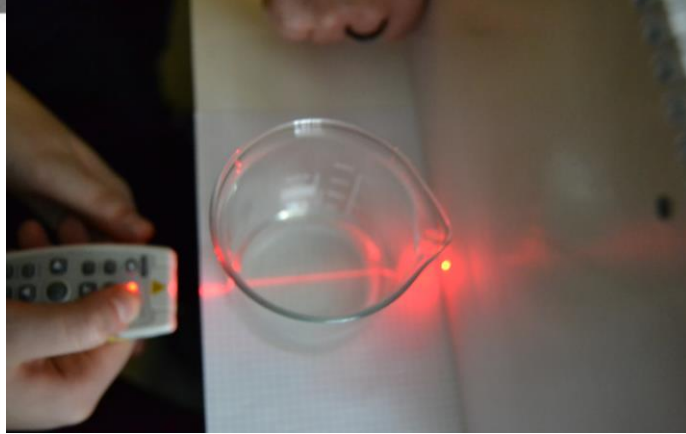
- Lasting 1-2 lessons
- Reasonably cheap materials and equipment
- Highlighting fundamental points:
  - › At the nanoscale new properties can be observed → **colloidal nanogold synthesis**
  - › self assembling → **LCD synthesis**
  - › nano in nature → **natural nanomaterials**
  - › Biomimetic engineering → **Lotus effect**
- Strong **interdisciplinary approach**: Physics, Chemistry, Biology

# Many properties of matter are determined at the nanoscale...



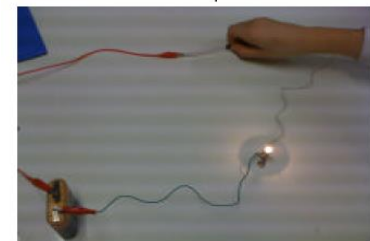
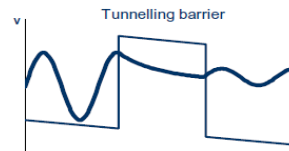
- **Gold nanoparticles synthesis** : colloidal gold
- Medical application as **colorimetric sensor**: students test them on different kinds of solutions discerning electrolytes from proteins.
- Light and matter interaction: **scattering** the change in aggregation level is signalled by the change in colour.

# Scientists work to make the most of atoms and molecules quantum behaviour to design new materials ...

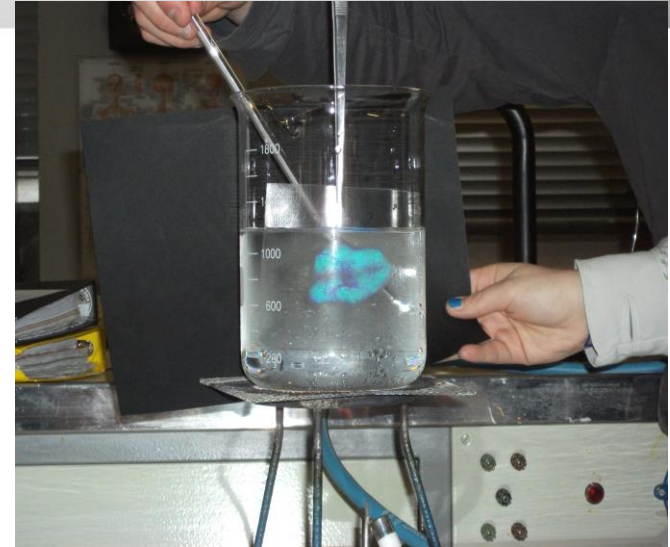


- In Nature many materials have properties resulting from their nanostructure when this is modified they do lose their usual aspect and their function with it → **colloids**, (milk, gelatin)
- manipulation at molecular and atomic level can lead to the design and synthesis of new materials with new functionalities such as conductive polymers or superadhesives

QTC  
pils



*... leading to many and appealing applications in different areas ranging from ICT to medicine and energy saving*



Students sometimes tested new materials:

- they worked as real “researchers” predicting, designing experiments, analyzing data and giving suitable interpretations (open inquiry modality)
- results often challenged their “school physics” (and teachers' too).
- samples were willingly donated by firms (even from USA)
- they felt it was the “real stuff”! Some tests were absolutely “first time”!

# More experimental activities integrated in the curricula

## Some examples:

- Forces at macro and nano scale : friction, adhesion and Van der Waals'. Gecko effect.
- Tuning electrical **resistance**: conductive polymers and QTC (Quantum tunneling composite)
- Metals **dilatation** and the counterintuitive behaviour of smart alloys.

(sustainability)

- Organic PV and Graetzel cells
- Light transmission in nanocoated glasses and polymeric thin films against green house effect
- Thermal insulating properties** of new building materials: aeroclay, aerogels
- Low **density** nanoporous materials for oil spilling containment and absorption



# Further actions: autumn 2011

## Università di Modena e Reggio E.

Teachers training in blended mode

- Seminars (researchers)
- Labs (expert teachers)

hoping to establish an intellectual **community** of committed and actively involved teachers + researchers willing to share and divulgate their results,

# Thank you for your attention!

**Le nanoscienze in laboratorio**  
Corso di aggiornamento teorico-pratico su nanoscienze e nanotecnologie per docenti di materie scientifiche

Organizzato nell'ambito del Progetto Lauree Scientifiche il corso fornirà agli insegnanti strumenti teorici e pratici per introdurre le nanoscienze e le nanotecnologie in classe ed in laboratorio.

Ciascun incontro sarà strutturato in due momenti:

- **seminario** tenuto da un ricercatore. Fornirà una panoramica generale del tema, nel contesto della attuale ricerca scientifica;
- **laboratorio** proporrà alcuni semplici esperimenti, facilmente replicabili in classe, svolta dai partecipanti.

**Mercoledì 19 Ottobre 2011**  
**Nanoparticelle**  
Seminario Guido Guidoni (Università Modena)  
Laboratorio Sintesi di nanoparticelle di zinco e loro utilizzo come catalizzatori

**Mercoledì 6 Novembre 2011**  
**Superfici nanostrutturate e nanotriologia**  
Seminario Andrea Salvetti (IDDA Trieste)  
Laboratorio Effetto Lotus ed effetto Gecko

**Mercoledì 22 Novembre 2011**  
**Polimeri conduttivi**  
Seminario Alex Netti (Università Modena)  
Laboratorio Polimeri conduttivi a tutti i contributi

**Mercoledì 6 Dicembre 2011**  
**Microscopia alla nanoscala**  
Seminario Stefano Diember (Università Modena)  
Giulia Paoletti (IDDA CNR NANO Modena)  
Laboratorio Dimostrazione sui principi di funzionamento della microscopia elettronica e della microscopia a sonda

**Mercoledì 20 Dicembre 2011**  
**Smart materials**  
Seminario Silvia Villa (ENI-CNR Iccr)  
Piero Alessio (IMEA-CNR Parma)  
Laboratorio Leghe a memoria di forma

lezioni dal 5 al 30 settembre sul sito: [www.physicocom.unimod.it](http://www.physicocom.unimod.it)

• Tutti gli incontri si terranno presso il Dipartimento di Fisica dell'Università di Modena e Reggio Emilia Via Campi 213/a, Modena  
• Orario 14.30-17.30