Master degree in Physics
Teaching and Research at the Physics Department of UniCal

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www.fis.unical.it
http://www.fis.unical.it/
Why study Physics?
To discover the laws underlying physical phenomena, by learning how to look at Nature through the same eyes of great physicists.
Galilei: [The universe] is written in mathematical language, and the letters are triangles, circles and other geometrical figures, …

Newton: Truth is ever to be found in the simplicity, and not in the multiplicity and confusion of things.

Faraday: Nothing is too wonderful to be true.

Maxwell: Thoroughly conscious ignorance is the prelude to every real advance in science.

Einstein: Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world.

Dirac: If you are receptive and humble, mathematics will lead you by the hand.

Fermi: If the result confirms the hypothesis, then you've made a measurement. If the result is contrary to the hypothesis, then you've made a discovery.

Feynman: Explore the world... everything is interesting if you go into it deeply enough.
The Master Degree in Physics will allow you to

- describe physical phenomena quantitatively and build theoretical interpretative models;
- use and develop advanced laboratory equipments;
- master programming languages for physical applications and big data analysis;
- use self-learning tools for rapid and continuous updating;
- work in a team, while possessing a high-level of autonomy, and smoothly join a workplace;
- present oral and written dissertations in a proficient English.
Why study Physics at UniCal?
> Lively campus

> Quality of research

> Internationalization

> Good teacher-to-student ratio

> Services and grants
Physics

It offers a common training area encompassing Computer Science, Mathematics, Chemistry, Physics and five specific areas covering:
- theoretical study and data analysis from Earth and Space, numerical simulation of astrophysical systems and Sun-Earth relations, plasma physics;
- theoretical, experimental and applicative study of matter physics, with particular reference to solid state physics, surface physics, biophysics and biomedicine;
- physics and technology of materials, with particular reference to soft matter, liquid crystals, optics and photonics, and the related characterization techniques;
- theoretical and experimental study of the physics of fundamental interactions, including the physics of elementary particles and the theory of quantum fields;
- physics of the atmosphere and meteo-climatic system, in accordance with the Organization World Meteorology.
Physics

**Curricula**

- Astrophysics, Geophysics and Plasma Physics
- Matter Physics
- Physics and Technology of Materials
- Nuclear and Subnuclear Physics
- Physics of the Atmosphere, Meteorology and Climatology

**Job opportunities**

Graduates will be able to face PhD and postgraduate specialization schools or to enter the professional world. Career opportunities include research in Physics and Applied Physics in public and private institutions; technological applications in industries (optics, mechanics, electronics, etc.); radiation protection in healthcare companies and analysis laboratories; software development, data analysis and modeling of complex systems in banks, insurance and consulting companies.
Laboratory plasmas: modelling and analysis of plasmas in magnetic confinement devices, aimed at reproducing nuclear fusion processes in stellar cores.

Solar corona: theoretical and numerical models to understand the origin of flares, CMEs, and the acceleration of the solar wind.

Solar surface: study of phenomena occurring on the Sun’s surface, such as sunspots. The number of sunspots is associated with solar radiation intensity and magnetic activity.

Solar wind: flow of charged particles in a highly turbulent regime. 3D numerical simulations to study the complex dynamics of the solar wind and collisionless shocks.
Astronomy and Cosmology
Molecular biophysics

Structural, dynamic and thermodynamic properties of molecules of biological interest and of complex biophysical systems such as proteins, self-assembled lipid structures and bio-inorganic structures.

Natural membrane: complex system that can be studied "in toto" and/or in individual parts

Human albumin

Protein-antioxidant interaction studied with fluorescence emission

Protein aggregation in β-amyloid filaments for biomedical research

Electronic Spin Resonance, Differential Microcalorimetry (DSC) and Optical Absorption and Fluorescence Spectroscopies are used. Theoretical and computational techniques are used such as simulated molecular dynamics (MD)
The group of Experimental Physics of Fundamental Interactions participates in the ATLAS experiment at LHC and other experiments with accelerators, to discover and measure the properties of the elementary constituents of matter and their mutual interactions.

Highlights: physics of the Higgs boson, search for dark matter

Technologies: IT, advanced data acquisition systems, particle detectors, programming in Object Oriented languages

Research in Theoretical Physics of Fundamental Interactions and in Mathematical Models and Methods: predictions for precision measurements at LHC, also through the simulation of fundamental interaction physics phenomena, development of exact techniques for the study of quantum systems and models, inspired by the physics of classical and quantum systems, to describe social phenomena such as traffic and epidemics.
Quantum technologies: an example of change of paradigm
Matter physics: optics and photonics
Matter physics: integrated circuits and opto-electronics

Scheme of an integrated circuit

Diodes

Contact lenses for augmented reality

Arduino
Matter physics: superconductors and magnetic levitation

Magnetic levitation trains

Superconductors at CERN
Matter physics: graphene

A material capable of conducting electricity better than copper, transparent like glass and more resistant than steel. Then imagine being able to fold it as if it were plastic, and thus create touchscreens to roll up and carry in your pocket.

What will graphene be used for? A question that not even the Nobel laureate Andre Geim can answer yet, as he was able to declare at the time of the Nobel. "I don't know. It's like presenting a piece of plastic to a man from a century ago and asking him what can be done about it. A bit of everything, I think."
**«MaTeRia» project**

“PON Materia” Project - Materials and Technologies for Advanced Research

STAR, the Italian X-ray factory, which UniCal and CNISM are building on the Arcavacata campus.
<table>
<thead>
<tr>
<th>Teachings</th>
<th>Area</th>
<th>Notes</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>Scientific data acquisition and processing</td>
<td>Physics</td>
<td></td>
<td>6</td>
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<tr>
<td>Advanced computer science for Physics</td>
<td>Computer Science</td>
<td></td>
<td>6</td>
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<tr>
<td>Advanced mathematics methods for Physics</td>
<td>Mathematics</td>
<td></td>
<td>6</td>
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<tr>
<td>Advanced quantum mechanics</td>
<td>Theoretical Physics</td>
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<td>Fundamental processes in astrophysics</td>
<td>Astrophysics</td>
<td></td>
<td>6</td>
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<tr>
<td>Physics of Complex systems</td>
<td>Physics</td>
<td></td>
<td>6</td>
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<tr>
<td>Nuclear and particle physics</td>
<td>Microphysics</td>
<td></td>
<td>6</td>
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<tr>
<td>Bonds, molecules, phases and phase transitions</td>
<td>Chemistry</td>
<td></td>
<td>6</td>
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<tr>
<td>Specific curriculum teaching 1*</td>
<td>Physics</td>
<td>Options: Space physics/ Matter physics lab/ Space weather/ Nuclear and particle physics lab/ Statistical mechanics/...</td>
<td>6</td>
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<tr>
<td>Specific curriculum teaching 2*</td>
<td>Physics</td>
<td>Options: Astrophysics and Geophysics lab/ Surface physics/ Physical methods in bio-medicine/ Meteorology lab/ Quantum field theory/ Theoretical condensed matter physics/...</td>
<td>6</td>
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## Physics Study plan

### Second year

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<tr>
<th>Teachings</th>
<th>Area</th>
<th>Notes</th>
<th>ECTS</th>
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</thead>
<tbody>
<tr>
<td>Specific curriculum teaching 3*</td>
<td>Physics</td>
<td><strong>Options:</strong> Solar physics and sun-earth connections/ Biophysics/ Solid state physics/ Soft matter physics/ Particle physics phenomenology/ Dynamics of the atmosphere/…</td>
<td>6</td>
</tr>
<tr>
<td>Specific curriculum teaching 4*</td>
<td>Physics</td>
<td><strong>Options:</strong> Advanced computational methods/ Linear and nonlinear spectroscopies/ Optics and Photonics/ Synoptic and mesoscale meteorology/…</td>
<td>6</td>
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<tr>
<td>Elective course 1</td>
<td>Elective</td>
<td></td>
<td>6</td>
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<tr>
<td>Elective course 2</td>
<td>Elective</td>
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<td>6</td>
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<tr>
<td>Thesis</td>
<td></td>
<td></td>
<td>36</td>
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And after graduation?
PhD schools

1) Physical, Chemical and Materials Sciences and Technologies

2) Science and Engineering of Environment, Buildings and Energy

Masters and post-graduate schools

e.g. Master in Ionizing Radiations and Radiation Protection (2017/18)
### Some statistics – Period 2017-2019

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Percentage of graduates with occupation three years after the Master Degree</td>
<td>85.7%</td>
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<tr>
<td>Percentage of graduates with occupation one year after the Master Degree</td>
<td>72.5%</td>
</tr>
<tr>
<td>Percentage of ECTS taken abroad within the normal duration of the Degree</td>
<td>4.7%</td>
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<tr>
<td>Percentage of graduates with at least 12 ECTS taken abroad within the normal duration of the Degree</td>
<td>31.8%</td>
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<td>Percentage of first-year students with the Bachelor Degree taken abroad</td>
<td>8.5%</td>
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<td>Percentage of Master Degree graduates within one year later than normal duration</td>
<td>77.4%</td>
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<tr>
<td>Percentage of students who would enroll again at the Master Course in Physics</td>
<td>85.5%</td>
</tr>
<tr>
<td>Percentage of graduated students completely satisfied</td>
<td>94.6%</td>
</tr>
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**Red**: better than National average  
**Blue**: better than South Italy average
Contacts

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