UNIVERSITÀ DI PISA

# PHYSICS 3

## GIOVANNI BATIGNANI

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| Anno accademico | 2019/20 |
| CdS | PHYSICS |
| Codice | 248BB |
| CFU | 9 |

| Moduli | Settore/i | Tipo | Ore | Docente/i |
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| FISICA 3 | FIS/04 | LEZIONI | 72 | GIOVANNI BATIGNANI<br>CLAUDIO BONATI |

### Prerequisites
Non relativistic mechanics.
Special relativity.
Elettromagnetism.

### Syllabus
**Investigation of subatomic systems, decays and collisions.**
Cross sections for waves. Total, differential, inclusive and exclusive cross sections. Examples for scattering of electromagnetic waves on electric charges, circuits, antennas. Radiative reaction force. Scattering and absorption of radiation by an oscilator; resonances, width and relationship with the lifetime.
Cross sections for particles. Examples: experimental data of proton-proton, electron-positron, neutrino-nucleon cross sections. Baryonic and Leptonic numbers and conservation laws.
Scattering Rutherford, discovery of strong interaction and experimental measurement of nuclear radii. Nuclear masses, nuclear binding energy and the nuclear drop model.
Decays, lefitimes and widths. Examples of nuclear alfa, beta, gamma decays; nutrinos and antineutrinos. Neutron decay. Pound e Rebka experiment. Reactions: energy thresholds, phase space. Examples: neutral and charged pion decays, production of neutrino beams. 3-body decays and the Dalitz plot, muon decay. Missing and invariant mass methods for short-lived particle identification.

**Advanced electromagnetism**
Covariant formulation of the electromagnetism: 4-vector potential, Maxwell's equations, gauge invariance, field-strenght tensor. Trasformation of electromagnetic fields. Strenght-energy-momentum tensor, invariant quantities under Lorentz transormations. Lienard-Wiechert potentials. Radiative power by accelerated charges, Larmor expressions.
Introduction to particle accelerators, radiation issues, synchrotron radiation.

**Interaction of charged particles and photons with stable matter**
Interaction of photons: Thomson and Rayleigh scatterings, photoelectric and Compton effects, electron-positron pair production off nuclei.
Interaction of charged particles: multiple scattering, energy loss by collisions, range, Cherenkov effect, bremmstrahlung and radiation lenght. Applications.
Form factors: examples of nuclear form factors.
Discussion of positron discovery. Class reading and comment of the paper of the antiproton discovery.

### Bibliography
- D. Jackson, “ClassicalElectrodynamics” (3^ Ediz.) John Wiley & Sons 2009.
- S.Krane, "IntroductoryNuclearPhysics", John Wiley & Sons, New York (per la parte riguardante gli argomenti di fisica nucleare)
- in the course page: https://elearning.df.unipi.it/course/view.php?id=219

### Assessment methods
Oral examination

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Class web page
https://elearning.df.unipi.it/course/view.php?id=219

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