Introductory nuclear and atomic physics

Lecturers
Nicolas PAULY (Coordinator) and Jérémy DOHET-ERALY

Course mnemonic
PHYS-H405

ECTS credits
5 credits

Language(s) of instruction
English

Course period
Second term

Campus
Solbosch

Course content

Orders of magnitude and conservation laws. Nuclear interaction. General properties of nuclei. Nuclear spectra and electromagnetic transitions (i.e. gamma radioactivity) and internal conversion. Notion of radioactivity: alpha, beta etc. Nuclear-structure models. Nuclear-reaction types. Cross section. Resonance and Breit-Wigner formula. Direct reactions. Composed nucleus. Induced and spontaneous fission. Fusion and radiative capture: application to nuclear astrophysics.

Atomic part:

Hydrogen atom and hydrogen-like systems. Helium atom and helium-like systems. Interaction of light with matter. Electronic structure of atoms with more than two electrons.

Objectives (and/or specific learning outcomes)

Understand the basic notions of nuclear spectroscopy and in nuclear-reaction theory used in most of the nuclear and optical engineering courses of the Master in Physical Engineering. Understand the basics of atomic physics. The laboratories will help the students to relate the theoretical developments seen in class with the actual measurement techniques.

Teaching method and learning activities

Lectures, exercices, laboratories and visit.

Contribution to the teaching profile

This course introduces the bases of the physical phenomena studied within the courses in nuclear and optical engineering of the Master in Physical Engineering. The nuclear-physics part covers the notions of radioactivity, nuclear spectroscopy and nuclear reactions (mainly fission and fusion). It is therefore directly related to the courses of Nuclear Reactor Physics, Métrologie Nucléaire, Physique des Plasmas, Dosimétrie...

The part on atomic physics introduces the notions of atomic structure and of interaction of light with matter, which constitute a prerequisite for the courses optical engineering of this Master: Laser Physics, Optical Materials, Optique non-linéaire, Quantum Optics,...

This course is also a prerequisite for the course Advanced Nuclear, Atomic and Molecular Physics. It also enables students to apply the notions seen in the courses of Mécanique Quantique I and II.

References, bibliography and recommended reading

- K.S. Krane, « Introductory Nuclear Physics » (Wiley, 1988)
- K. Heyde, « Basic Ideas and Concepts in Nuclear Physics » (Institute of Physics, 1994)
- S.S.M. Wong, « Introductory Nuclear Physics » (Wiley, 1998)
- B.H. Bransden and C.J. Joachain, « Physics of Atoms and Molecules » (Prentice Hall, 2003)
- B.R. Judd, « Operator Techniques in Atomic Spectroscopy » (Princeton Landmarks in Physics, 1998)
- W.R. Johnson, « Atomic Structure Theory » (Lectures on Atomic Physics, Springer, 1998)
- R.D. Cowan, « The Theory of Atomic Structure and Spectra » (Los Alamos Series in Basic and Applied Sciences, 1981)

Other information

Place(s) of teaching

Solbosch

Contact(s)

Nicolas Pauly (Nicolas.Pauly@ulb.be) and Jérémy Dohet-Eraly (jdoheter@ulb.ac.be),

Evaluation method(s)

written examination

Evaluation method(s) (additional information)

A written exam divided into two parts and lab reports.

Determination of the mark (including the weighting of partial marks)

The grade is composed of the grade obtained at the written exam (45% for the atomic part and 45% for the nuclear part) and of the grade obtained for the laboratories (10%). However, in the case

where the grade obtained for the atomic part of the written exam or for nuclear part of the written exam is less than 6/20, the exam average will be equal to the lowest value of the 2 parts.

Main language(s) of evaluation

French and English

Programmes

Programmes proposing this course at the Brussels School of Engineering

MA-IRPH | Master of science in Physical Engineering | finalité Professional/unit 1