Course title **MODERN PHYSICS**

Contact information

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other teachers

Prof. François MONTANET
Prof. Johann COLLOT

Course book

general reading : “Modern Physics for Scientists and Engineers” S. Thornton/A. Rex, Brooks/Cole
more specific literature is announced separately in the different parts

Course

The Modern Physics course consists of 4 different parts (parts A + B are taught in the first half of the semester, parts C + D in the second half)

PART A (G. Seyfarth)

Introduction to Quantum Physics
15h → lectures (5*1h30), tutorials (5*1h30)

I. Basic principles

→ Superposition principle
→ particle-wave duality
→ de Broglie relation
→ Heisenberg's uncertainty principle

II. Single-particle wave function and Schrödinger equation

→ Harmonic oscillator
→ infinte potential well
→ H atom (only main quantum number)
→ Tunneling

III. Interaction light ↔ matter

→ Absorption, stimulated and spontaneous emission

IV. Outlook

→ Identical particles and Pauli principle

PART B (F. Montanet)

Nuclear Physics

15h → lectures (5*1h30), tutorials (5*1h30)

I - Properties of nuclei

1) Introduction and basic knowledge

Rutherford experiment
Elementary forces and particles
Properties of the nucleons
Interactions between nucleons

2) Properties of nuclei

Conventions and definitions
Nuclear size
Nuclear masses & units (MeV, amu)
Mass defect, binding energy
Semi-empirical formulae
Nucleus exited states, gamma-ray deexcitation.

3) Radioactivity

Radioactive decay law
Half-life and radioactive constant
Activity

II - Nuclear reactions

1) Introduction

Transformations
Conservation laws
Types of radioactive decays
Induced reactions

2) Rest mass energy balance

Mass defect and binding energy
Mean binging energy per nucleon

3) Induced reactions

Classical mechanics reminder
Kinetics of nuclear reactions: threshold
Coulomb barrier
Reaction cross-section

4) Radioactive decays

2-body decays
3-body decays
Decay diagram and branching ratios

PART C (J. Collot)

Relativity
15h → lectures (5*1h30), tutorials (5*1h30)

Principles of special relativity

→ Physical implications & Lorentz transformation
→ Experimental tests of special relativity
→ Minkowski's 4-d space-time
→ Relativistic dynamics

Outlook : towards general relativity

PART D (J. Collot and G. Seyfarth)

Laboratory course
20h → 5 lab sessions (5*4h) for groups (2 students)
BU students and Grenoble (UGA) students work together as French-American groups

Millikan oil drop experiment

Electron diffraction (particle-wave duality)

Atomic spectra (Balmer series of hydrogen)

Stefan-Boltzmann law / solar radiation / Emittance / Irradiance

Photovoltaic effect

Evaluation/Grading

2 oral exams
→ midterm : Quantum Mechanics or Nuclear Physics
→ end of semester : Relativity

2 written exams
→ midterm : Quantum Mechanics and Nuclear Physics
→ final : Relativity and Laboratory Course

For each lab session a report (one per group) is mandatory and will be graded.

weights for the final grade :

35% written exam QM + NP
35% written exam Relativity + lab course
15% oral exam QM/NP
7.5% oral exam relativity
7.5% lab reports