10563-748 (8) Nuclear Reactions & Nuclear Structure (1½l, 1½p)

2017

Course summary:

Nuclear reactions: Scattering kinematics basic concepts. Elastic scattering, the optical model. The study of reaction mechanisms, e.g. compound nucleus formation, direct reactions, pre-equilibrium processes. Reactions with light projectiles, e.g. inelastic scattering, transfer reactions, knockout reactions. Heavy ion reactions, fragmentation. Electron scattering and high-energy nuclear reactions.

Nuclear structure: Two-nucleon systems (e.g. deuteron): interaction of nucleons and the inclusion of properties like charge independence and spin dependence. The Yukawa theory of meson exchange. Multiple nucleon systems: The nuclear shell model (single and multi-particle, introductory). Rotational and vibrational effects in nuclei (the collective model).

Module relevance in programme:

This module provides the student with the required background about the properties of the atomic nucleus and the models used to describe the structure of the nucleus, as well as the observables used to predict the outcome of nuclear induced reactions. Students are also exposed the latest developments in the field of nuclear physics. The module requires previous knowledge such as undergraduate quantum mechanics 254, 334 and builds on the introduction to nuclear physics in on 352

Outcomes of course:

Equips the student with a working knowledge of nuclear structure and reactions mechanisms on a post graduate level. This course forms the basis for more advanced courses in nuclear physics and is essential for any student aiming to do postgraduate research in nuclear physics.

Lecturer:

Prof SM Wyngaardt
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Mentor:

The Department of Physics has appointed a staff member as mentor for each year of its physics programme to be available to students for consultation. Students should feel free to discuss general issues related to the physics programme or specific modules in the programme with the relevant mentor, in addition to usual consultations with their individual lecturers of modules.

The mentor for the Honours programme and its modules is Prof KK Müller-Nedebock kkmn@physics.sun.ac.za.

Course content:

Formal lectures

NUCLEAR STRUCTURE AND NUCLEAR REACTIONS (approximately 24 lectures)

General properties of nuclei and interaction of nucleons
Constant nuclear density of nuclei
Binding energies
The shell model of nuclei
Shape of the nuclear potential;
General properties of nucleon-nucleon forces
Systems in which nuclear forces may be investigated
The two-nucleon system
The spin-dependent term
Properties and analysis of the deuteron:
Radial equation;
Magnetic dipole moment;
Electric quadrupole moment
Deuteron versus di-proton and di-neutron
Nucleon-nucleon scattering
The nucleon-nucleon potential
The properties and structure of the nucleons

Practical (Tutorials):

Tutorials will be done on a weekly basis

Study material:

K. Krane, Introductory Nuclear Physics, Wiley, B. Povh, K. Rith, C. Scholz, F. Zetsche, Particles and Nuclei, Springer

Learning opportunities:

Lectures as per time table

Assessment:

Methods of Assessments
Two papers of 3 hours duration each (one paper after completion of each section)
Weekly classroom exercises and homework assignments

Venue and time of assessment opportunities
See timetable

Availability of marks:
As soon as possible

Calculation of final mark for the module:
Class mark = Homework Assignments (70 %) + Classroom exercises (30 %)
Final mark = Class mark (20%) + Test 1 (40%) + Test 2 (40%)