UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Application of Neutron Physics

2627-1-F1703Q001

Aims

The aim of the course is to understand the role of the neutron in Physics and its importance in some of today's applications such as Nuclear fission, Nuclear Fusion and Neutron scattering experiments.

In addition, the course aims to describe the Physics principle on which the detection of neutrons is based and on the instrumentation techniqes used for spectroscopy of 2. and 4 MeV neutrons in DD and DT

Contents

The course deals with the physics of slow and fast neutrons and their main applications: neutron scattering, fission and nuclear fusion.

Particular emphasis is given to the Physics principles that are used for the detection of neutrons, including neutron spectroscopy. spcial focus is given to the neutron diagnostics of thermonuclear plasmas.

Detailed program

1. The neutron as elementary particle.

Discovery of the neutron (Chadwick + reading Nature article and other papers)

Main properties of the neutron

Neutron sources (Radioisotopes, DT generators, spallation pulsed sources)

2. Neutron detection

Direct nuclear reactions, compound nucleus, resonance

Neutron cross sections

Methods for the detection of slow neutrons

Methods for the detection of fast neutrons and spectroscopy

3. Neutron Scattering

Neutron Scattering in central potential

Elastic scattering and diffraction at the Bragg

Inelastic scattering

4. Neutrons for the study of condensed matter

Diffraction by crystals

Neutron spectroscopy

Instrumentation for scattering experiments

5. Advanced instrumentation for neutron spectroscopy of fusion plasmas

MPR, TOFOR, derivation of random coincidence background

6 Neutron and Nuclear Energy

Derivation of the semiempirical formula for binding energy of the nucleus.

Nuclear fission. Neutron moderation, lethargy. Transport and neutron scattering.

The fission reactor: the 4-factor formula, examples of reactors, radioactive waste problem

Magnetic thermonuclear fusion. Derivation of the Lawson criterion and energy balance. Alpha particles and Q value.

Thermonuclear fusion, inertial confinement: Lawson criterion, diagnostic spectrum of neutrons and neutron

Movie: “I ragazzi di Panisperna”

7 (optional)

Seminar/practical exercises on the simulation code MCNP

Soft errors caused by the interaction of atmospheric neutrons

Prerequisites

it is prefable that the student have completed the three year degreee in Physics on Engeneering.

the class is open to all the student of the master degree in Physics.
particpation to the classroom is reccomended.

Teaching form

lessons in the class with the black dashboard
oral examination based on three questions.

Textbook and teaching resource

Testo: *G, F, Knoll, “Radiation detection and measurement”*

K. S. Krane, “Introductory nuclear physics”

C.G. Windsor, “Pulsed neutron scattering”

G. L. Squires, “Introduction to the theory of thermal neutron scattering”

additional materials will be provided by the teacher such as scientific journals or notes

Semester

usually the first semester

Detailed schedules are agreed each year with the students to minimize possible overlaps with other courses.

Assessment method

oaral examinatio aimed at assessing the comprehension of the course topics. The duration of the oral exam is on average 45/60 minutes.

During the class the students are invited to study in more detail a topic of the course, with an in-depth analysis through scientific articles distributed by the teacher

On request the exam can be sustained in English.

Office hours

to be arranged with the teacher via email

Sustainable Development Goals

QUALITY EDUCATION | AFFORDABLE AND CLEAN ENERGY