ISOTOPIC METHODS

3, 4 semestral M.Sc. studies held at the Faculty of Mathematics and Physics
Silesian University of Technology
since academic year 2010/11

Additional courses are not included

Gliwice, May 25, 2010

Program of 3 semestral study

SEMESTER 1

Modern physics (30h lectures + 30h exercises)

Physics of condensate state (30h lectures)

Types and properties of fundamental interactions. The impact of the strong, weak, electromagnetic and gravitational. Impact in the nucleus of an atom.
Structure and properties of atomic nuclei in the ground state. Isotopes, isobars, izotony, kernel mirror. Size and shape of atomic nuclei. Kernel weight distribution. The density of nuclear matter. The structure of the nucleon carrier. Nucleus binding energy.
Spin and electromagnetic moments of nuclei. Parity and spins of the nuclei. Statistics nuclei. Conservation laws in nuclear physics. Types and ownership transformation of radioactive nuclei.
Quantum theory of transformation of α. Fermi theory of β transformation. Failure to parity in weak interaction. Successive radioactive decay. Natural radioactive series of elements. Radioactive equilibrium in the ranks. Radioactive isotopes in the crust, atmosphere and hydrosphere.
Isotopes cosmogenic. Stable isotopes in the Earth's environment. Isotopic methods of determining the age of geological and archaeological sites. The importance of stable and radioactive isotopes in the reconstruction of environmental changes on Earth.
Interaction of nuclear radiation with matter. The total and differential cross-section. The impact of heavy charged particles, radiation, β, γ and neutrons. Types and operating principles of nuclear detectors.
Properties of nuclear forces. The replacement nature of nuclear forces. Methods of testing of nuclear interactions. Property deuteron. Nucleon-nucleon scattering at low energies. The impact of nucleon-nucleon at high energies. Resonant states of matter and production of new particles.
Models of the atomic nucleus. Models of strong and weak coupling of collective degrees of freedom of nucleons in the nucleus. Semi-empirical mass nuclei. Nuclear fission of nuclei based on a model drip. Chain reaction. Structure and types of nuclear reactors.
The model Fermi gas nucleus. Model coating kernel. Model of collective vibration. Collective rotational model.
The mass balance - energy in nuclear reactions. Energy transformation α, β and uptake K. Energy fusion and fission reactions. Controlled thermonuclear fusion. Fusion reactors.
Thermonuclear reactions in the sun and stars. Cycles of production elements. Cosmic rays: composition, energy spectrum of protons. The great cascade of particles. Cosmic neutrinos. Methods of detection of cosmic radiation.
Lifetimes, and loads of mass of elementary particles. The number of quantum particles: spin, izospin, Baryon and lepton number, strangeness, hiperładunek. Interactions of elementary particles and the conservation laws. The history of discoveries of elementary particles.
Particle accelerators. The November revolution in the history of the particles. Standard Model particles. Properties of leptons. Properties of quarks. Quantum chromodynamics. Supersilne impact.
The theory of the expanding universe. Relict radiation. Dark matter. Big Bang theory and evolution of matter in the universe.

Numerical methods (30h lectures +45h laboratory)

Elements of matter structure (30h lectures + 30h seminar)

Detection and spectrometry of particle radiation (30h lectures +45h laboratory)

Sources of nuclear radiation. Interaction with matter of heavy charged particles.
Ionization of atoms center. The absorption ranges of particles. Energy loss per unit path.
The impact of beta radiation with matter. Total and Differential cross sections. The ionization cross section, elastic and inelastic collisions with nuclei of atoms and electrons.
Positron Annihilation. The absorption of beta particles.
Influence of gamma radiation with matter. Cross-section for photoelectric effect, Compton and pair creation. Total cross-section.
Interaction of neutrons with matter. Elastic scattering on light nuclei. Nuclear reactions with emission of charged particles. Induced radioactivity of nuclei.
Trace particle detectors. Fog chamber and vesicular. Photographic emulsions. Dielectric trace detectors. Spark chamber. Ionization counters.

Counters of the flat and cylindrical electrodes. Ionization chambers, proportional counters and Geiger-Muller. Registration of individual particles.
Applications of ionization counters in measuring the natural radioactivity of the environment.
Scintillation counters. Types and properties of scintillators. Registration scintillation, construction and application of scintillation detectors.
Scintillation spectrometry of natural alpha, beta and gamma. Cherenkov counters.
Solid-state detectors. Go ionizing particles by solid-state interface. With surface barrier detectors, lithium diffusion.
Properties and application of semiconductor detector.
Spectrometry Semiconductor natural radioactivity of the environment.
Statistics measuring the registration of nuclear radiation.

Laboratory of physics (45h laboratory)

SEMESTER 2

Physics of condensate state (30h lectures)

Numerical methods (30h lectures +45h laboratory)

Laboratory of physics (45h laboratory)

Dosimetry of particle radiation (30h lectures + 30h exercises)

Isotopic mass spectrometry (30h lectures + 15h laboratory + 15h seminar)
Chemical elements, atoms, isotopes, isobars. Ions. Ionization. Movement of ions in the electromagnetic field.
Isotopic fractionation. Natural concentrations of selected isotopes.
The principle of mass spectrometry.
Ion sources in mass spectrometry: electron ionization, plasma ionization, ionization by collision.
Separation of ions in an electric field, separation of ions in the electromagnetic field.
Methods of recording ionic currents. Preparation of samples.
Isotope mass spectrometer with dual inlet.
Isotope mass spectrometer with a continuous flow system.
Elemental analyzers in the isotopic mass spectrometry.
Analyzers carbonates and the isotopic laser ablation mass spectrometry. Method ekwilibracji.
Isotope mass spectrometry with chemical separation.
Isotope mass spectrometry using the phenomenon of resonant absorption of infrared radiation.
Heavy-ion mass spectrometry.
Accelerator mass spectrometry. Medical use of isotope mass spectrometry.

Isotopic measurement in nuclear energetic (15h lectures + 30h exercises + 15h seminar)

Particle radiation protection (30h lectures)
Nuclear radiation and ionizing radiation. Sources of ionizing radiation. Nuclear materials.
Impact of ionizing radiation on living organisms.
Concepts: equivalent dose, effective dose (effective), the collective dose. External exposure to ionizing radiation, absorbed.
Applications of industrial, medical, scientific and special sources of ionizing radiation
Act,,"Atomic Law.
Rules for implementing the Act,"Atomic Law. Organization of services protection against ionizing radiation in Poland.
Measurements in radiation protection.
Isotope Laboratories. Nuclear facilities. Transport regulations.
Design of shielding against ionizing radiation. Design studio isotope, X-ray.

Working with sources of ionizing radiation. Radioactive contamination, detection of contamination, methods of removing contamination.
Radioactive waste.
Estimating the risks from natural radioactive isotopes. Radiation hazards in mining. Radiation hazards from cosmic radiation.
Radiation Protection in Nuclear Energy.
Radiation accidents. Accidents at nuclear installations. Contingency planning.

Geochemistry of isotopes (30h lectures + 30h seminar)

Basic concepts of geochemistry - elements and their occurrence in the universe. Basic concepts of isotope geochemistry.
Isotope geochemistry as a tool for environmental studies and restoration of contemporary environmental change in the past.
The main elements used in environmental studies. Patterns used in isotopic studies.
Measurement methods and sample preparation methodology. Problems of standardization of methods and results.
Hydrogen isotope geochemistry and oxygen. Hydrogen and oxygen isotopes in precipitation.
Tritium in atmospheric waters. Isotope Fractionation during evaporation and condensation.
Hydrogen and oxygen isotopes in ice and snow. Elements of isotope hydrology.
Carbon isotopes. The isotopic composition of carbon in the biosphere.
The isotopic composition of organic carbon in sediments, and fossil fuels.
The isotopic composition of carbon in the atmosphere. 14C: the formation and circulation in nature, the main reservoirs of the isotope 14C, 14C isotope of anthropogenic origin.
Carbon isotopic composition of carbonate rocks of primary and secondary carbonates and shells.
Isotopes of sulfur. The isotopic composition and fractionation of sulfur isotopes in the environment.
Isotopes of nitrogen. The occurrence of 15N isotope in the environment: organic matter, soil, hydrosphere. Examples of use.
Isotopic geochemistry of uranium. The isotopic composition of natural uranium. Isotopic composition of uranium in marine waters, ocean and inland.
Isotopic methods in geochronometry. The use of isotopes for dating rocks and minerals using radiocarbon, Uranium-track, leaded and luminescence methods.

Isotopic control of food, fuel and construction materials (15h lectures + 15h laboratory)

Biochemical composition of food products.
Light stable isotopes, C-14, H-3 in the modern biosphere, fossil fuels.
A number of uranium, track, K-40, Cs-137 in the lithosphere.
C-14 and H-3 in the study of origin and composition of fuels.
The use of light stable isotopes in the study of origin and composition of food products.
Study the contents of a series of uranium isotopes, thorium, and K-40 building materials.
Measurements of indoor radon concentration.

SEMESTER 3

Fundaments and applications of luminescence method (30h lectures + 15h seminars)

Thermoluminescence (TL) and optically stimulated luminescence (OSL) in solids
Model-band luminescence. Formation mechanisms of luminescence
Quenching thermal emission thermal power emission, anomalous luminescence decay and other phenomena affecting the properties of the emitted luminescence
Natural and artificial luminescent materials
Methods for determining the physical quantities describing the TL and OSL
Numerical modeling of luminescence in quartz
The measurement methods used in the applications of luminescence dosimeter
Analysis of OSL decay curves and growth curves. Application of genetic algorithms
Environmental dosimetry using TL and OSL
Retrospective dosimetry using building materials and other
Luminescence dosimetry in medical applications
Luminescent dating method
Luminescent signal problem zeroing in different sedimentary environments
Selected problems of geological and archaeological sites, employing luminescence dating.

Fundaments and applications of radiocarbon method (30h lectures + 15h seminars)

Natural production of radiocarbon. Conditions for the production rate. Volatility of 14C isotope production rate in history. Long-term change in the rate of production.
Effect of geomagnetic field on the rate of production. Effect of variable solar activity in the short-term changes in the production rate of 14C.
The main reservoirs of carbon on Earth. Radiocarbon and the carbon cycle on Earth. Differentiation between the carbon isotopic composition of reservoirs. The carbon cycle and radiocarbon in the atmosphere.
Inorganic and organic Carbon in the ocean.
The exchange of carbon and radiocarbon between the atmosphere and the ocean. Circulation of carbon in the ocean. Mechanisms for the exchange of carbon and radiocarbon between the atmosphere and land biosphere.
Models of the carbon cycle on Earth, and radiocarbon. Radiocarbon as the isotope trace in modeling the carbon cycle on Earth. Types of models and their characteristics. Model box- diffusion. Model Pandora.
Global carbon cycle and changes in patterns of radiocarbon and its concentration in the atmosphere. Effect of mass of the biosphere and the ocean's role in the evolution of the concentration of radiocarbon in the atmosphere. The pace of acquisition of the ocean carbon dioxide emitted into the atmosphere during the industrial.
Production and dilution of the isotope 14C by human activity. The effect of an atomic bomb. Production of radiocarbon in the environment of nuclear power plants. Changes in the concentration of the isotope 14C by the combustion of fossil fuels.
Changes in exchange rates between the carbon reservoirs. Changes in ocean ventilation rate of global growth as the cause of atmospheric concentration of 14C.
Methods for testing the concentration of radiocarbon and stable isotope 13C in different environments of the Earth. The method of proportional gas counters, liquid scintillation spectrometry of beta radiation, and accelerator mass spectrometry. Measurement of carbon isotope fractionation by mass spectrometry.
Radiocarbon and stable 13C in the biosphere. Reactions of photosynthesis, carbon uptake by plants. Carbon isotopes in annual increments of trees.
Record of industrial carbon dioxide emissions to the atmosphere in the isotopic composition of atmospheric radiocarbon in carbon dioxide and the annual increments of trees. Regional and global effects Suesa.
Application of radiocarbon method to create a calendar time scale of modern biogenic sedimentation, lymnic and karst areas.
The use of radiocarbon in the processes of quality control in food production (vinegar and alcohol), packaging and fuel. Applications in medicine.

Isotopic archive of climate changes (30h lectures + 30h seminars)

Definition of climate and its components (atmosphere, oceans, continents, biosphere and criosphere) and its elements (air temperature, precipitation, air pressure, sunlight and wind). Extraterrestrial and terrestrial reasons of climate changes. Milankovitch cycles. Water circulation in ocean and its implication for climate changes. NADW. Climate changes on the geological scale. Glacial-interglacial cycle in Quaternary. Ruddiman's hypothesis. Data proxy. Frequency distribution of U/Th and radiocarbon data as proxy of climate changes.

Radioisotopic method of dating (30h lectures + 15h exercises + 30h laboratory)

Radioactive decay and its applications in radioisotopic dating in geology. K/Ar method. Ar/Ar method. Rb/Sr method. Methods applying isotopes of uranium series. Radiocarbon method. Tritium as a tool of dating. Dating using cosmogenic isotopes (^{10}Be, ^{26}Al, ^{36}Cl). Re/Os method. Sm/Nd method. Other radioisotopic method for dating. Statistic method in data assimilation.

Program of 4 semestral study

SEMESTER 1

Modeling of physical processes (30h lectures + 15h laboratory)

Electric and electronic survey (30h lectures + 30h laboratory)

Introduction to optoelectronics (15h lectures + 30h laboratory)

Experimental methods of technical physics (30h lectures + 45h laboratory)

Solid state physics (30h lectures + 30h exercises)

Method of data assimilation (15h lectures + 30h exercises)

Introduction to numerical methods (15h lectures +30h laboratory)

Nuclear reactors (30 h lectures)

Elements of geophysics (30 h lectures)

SEMESTER 2

Modern physics (30h lectures + 30h exercises)

Physics of condensate state (30h lectures)

Numerical methods (30h lectures +45h laboratory)

Elements of matter structure (30h lectures + 30h seminar)

Detection and spectrometry of particle radiation (30h lectures +45h laboratory)

Laboratory of physics (45h laboratory)

SEMESTER 3

Physics of condensate state (30h lectures)

Numerical methods (30h lectures +45h laboratory)

Laboratory of physics (45h laboratory)

Dosimetry of particle radiation (30h lectures + 30h exercises)

Isotopic measurement in nuclear energetic (15h lectures + 30h exercises + 15h seminar)

Particle radiation protection (30h lectures)

Geochemistry of isotopes (30h lectures + 30h seminar)

Isotopic control of food, fuel and construction materials (15h lectures + 15h laboratory)

SEMESTER 4

Fundaments and applications of luminescence method (30h lectures + 15h seminars)

Fundaments and applications of radiocarbon method (30h lectures + 15h seminars)

Isotopic archive of climate changes (30h lectures + 30h seminars)

Radioisotopic method of dating (30h lectures + 15 exercises + 30h laboratory)
Radioactive decay and its applications in radioisotopic dating in geology. K/Ar method. Ar/Ar method. Rb/Sr method. Methods applying isotopes of uranium series. Radiocarbon method. Tritium as a tool of dating. Dating using cosmogenic isotopes (^{10}Be, ^{26}Al, ^{36}Cl). Re/Os method. Sm/Nd method. Other radioisotopic method for dating. Statistic method in data assimilation.

All information available on webpage:

http://matfiz.polsl.pl/aktualnosci.php?wid=6

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