Nuclear Physics I

Physics 551

Spring 2005

Instructor: Norbert Pietralla
(office: Physics C-112, (631) 632-8119, Norbert.Pietralla@stonybrook.edu)

Lectures: Mondays, Wednesdays, Fridays 11:45 - 12:40
Room P-123
First meeting: Jan 24

Topics:

I. Basic Concepts
   Units, sizes, conventions, nuclear chart, cross section, brief history
   and prospectives

II. Nucleon Structure
    Elementary particles and forces, overview over the basic hadrons,
    isospin, parity

III. Deuteron and Nuclear Force
     two-nucleon systems, scattering, properties of the deuteron, prop-
     erties of the nuclear force, meson-exchange model

IV. Nuclear Properties
    Radii, density, mass formula, binding energy, separation energies,
    drip lines, fission, ground state spin, magnetic dipole moments of
    odd-mass nuclei, independent-particle shell model, magic num-
    bers

V. Nuclear Astrophysics
    Stellar energy production, nucleosynthesis, hydrogen burning,
    CNO-cycle, solar neutrino problem, neutrino oscillations, nuclear
    physics of supernovae and neutron stars

VI. Electroweak decay processes
    Transition rates, Fermi’s golden rule, $\gamma$-decay, Weisskopf units
    and collectivity, $\beta$-decay, isospin mixing, parity violation
VII. Nuclear collective motion
   Geometrical model, vibrations, giant resonances, rotations, deformation phase transitions, interacting boson model

VIII. Microscopic nuclear structure models
   Many-body basis states, mean field, Tamm-Dancoff approximation, random phase approximation, pairing, interacting shell model, Nilsson model

IX. Nuclear reactions
   Nuclear resonance fluorescence, Coulomb excitation, compound nucleus formation, direct reaction, optical model, scattering

X. Accelerators
   Electrostatic accelerators, cyclotrons, synchrotrons, storage rings, \( \gamma \)-ray sources, linear accelerators, visit of the Stony Brook TANDEM-LINAC ion-beam accelerator

XI. Detectors and counting statistics
   Interaction of radiation with matter, stopping power, gas-filled counters, scintillators, semiconductor detectors, energy measurements, mean value and variance, background, coincidence measurements, angular correlations, measurement of nuclear level lifetimes

XII. and Nuclear Physics II:
   Contemporary topics in nuclear physics research

**Grading:** 20% mid-term exam, 30% final exam, 50% homework

*last updated 1/10/2005*