MANGALORE UNIVERSITY

Department of Physics

MSc Physics

PHS 555: NUCLEAR PHYSICS III

(52 Hrs.)

Course outcome

CO1 The student will know about various nuclear models.

CO2 The student will know about Nuclear reactions.

CO3Will have good understanding of Born approximation.

Unit I Nuclear models

Fermi gas model: kinetic energy for the ground state-asymmetry energy - nuclear evaporation.

Independent particle model: motion in mean potential, energy levels according to harmonic oscillator potential and infinite square well potential - effect of spin-orbit interaction.

Prediction of ground state spin, parity of odd-A nuclei and odd-odd nuclei - magnetic moments of odd-A nuclei and quadrupole moment. [13 hrs]

Unit II Nuclear shell model

Shell model for one nucleon outside the core-configurations for the excited states. Model for two nucleons outside the core. Residual interaction - ^{18}O Spectrum (qualitative) for two particles in $d_{5/2}$ orbit and in $d_{5/2}$ - $s_{1/2}$ orbits.

Collective model: collective vibrations and rotations. Nuclear quadrupole moments. Nilsson model - calculation of energy levels - prediction of ground state spin.[13 hrs]

Unit III Nuclear reactions: Background information for nuclear reaction, neutron induced reactions, cross-sections, gross-structure problem, features of direct reaction model and compound nucleus model. Optical model- forms and features of optical potential.

Partial wave approach: partial wave analysis of nuclear reactions-expressions for scattering and reaction cross sections and their interpretations, total cross section, optical theorem, shadow scattering. Resonance theory of scattering and absorption. Breit-Wigner formulae. **[13 hrs]**

Unit IV Perturbation approach: Determination of nuclear reaction cross section based on perturbation theory, evaluation of cross-section near threshold. Inverse reactions - principle of detail balance, determination of spin of pions.

Transfer reactions - semiclassical description. Plane wave Born approximation (PWBA) - its predictions of angular distributions – modifications. Distorted Wave Born Approximation (DWBA) (qualitative) - spectroscopic factors and their significance. **[13 hrs]**

Text Books:

1. Segre E, 'Nuclei and Particles', II Edn. (Benjamin, 1977)
2. Preston M A and Bhaduri R K, 'Structure of the Nucleus' (Addison Wesley, 1975)
3. Ghoshal S N, 'Atomic and Nuclear Physics', Vol. I & II (S Chand & Company, 1996)
4. Roy R K and Nigam P P, 'Nuclear Physics - Theory and Experiment' (Wiley Eastern Ltd., 1993)
5. Enge H, 'Introduction to Nuclear Physics' (Addison Wesley, 1988)
6. Sachler G R, 'Introduction to Nuclear Reactions', II Edn. (Macmillan Press, 1990)

Reference Books:

1. Marmier D and Sheldon E, 'Physics of Nuclei and Particle', Vol. I & II (Academic Press, 1969)
2. Blatt J M and Weisskopf V F, 'Theoretical Nuclear Physics' (John Wiley, 1952)
3. Krane K S, 'Introductory Nuclear Physics' (John Wiley, 1987)
4. Perkins D H, 'Introduction to High Energy Physics', II Edn. (Addison Wesley, 1982)
5. Soodak H and Campbell B C, 'Elementary Pile Theory' (John Wiley, 1950)