PH702 Advanced Quantum Mechanics

Credit: (3-0-0-3) Approval: Approved in 2nd Senate

Prerequisite: Consent of the faculty member

Students intended for: Ph.D.
Elective or core: Elective Semester: Odd/Even

Course content:

- Review of basic concepts in quantum mechanics, measurements, observables and generalized uncertainty relations, change of basis, generator of translation [3 lectures]
- Rotations and angular momentum commutation relations, spin-1/2 systems and finite rotations of general theory of angular momentum, addition of angular momenta, Clebsch-Gordon Coefficient (CGC) and its properties, conventions of CGC, choice of phases and 3-j symbols, Schwinger's oscillator model of angular momentum [4 lectures]
- Tensor operators, Cartesian tensors, irreducible tensor operators, matrix elements of tensor operators, Wigner-Eckart theorem and its applications [4 lectures]
- Symmetry principles in quantum mechanics, conservation laws and degeneracies, discrete symmetries, parity and time reversal, symmetry in collision and ionization process [4 lectures]
- Approximation methods in quantum mechanics, review of non-degenerate perturbation theory, degenerate perturbation theory, time dependent perturbation theory, periodic perturbation, Rabbi flopping frequency, Adiabatic approximation, Berry phase, sudden approximation [5 lectures]
- Interaction of quantum systems with radiation, Dipole approximation and selection rules, length, velocity and acceleration forms of matrix transition matrix elements, Absorption process, spontaneous emission, stimulated absorption, Einstein coefficients, life times, line intensities, widths and shapes [5 lectures]
- Many electron atoms, central field approximation, self-consistent field method, Hartree-Fock equations, Koopman's theorem [5 lectures]
- Relativistic quantum mechanics, Klein-Gordon equation, Dirac equation, probability densities and current densities, plane wave solutions of Dirac's equation, solutions of the Dirac equation for a central potential, non-relativistic limit of Dirac equation, negative energy states and hole theory [5 lectures]
- Second quantization, creation and destruction operators, occupation numbers, commutation relations, matrix elements of H for N-electron systems, field operators [5 lectures]

Text & Reference Books:

Modern quantum mechanics – J.J. Sakurai

Quantum Mechanics -Vol.1& II– Cohen-Tannoudji, B Diu, F Laloe

Quantum Mechanics-Vol.1 & II-Messiah

Quantum mechanics-Bransden and Joachain

Physics of atoms and molecules-Bransden and Joachain

Principles of quantum mechanics-R Shankar

Many-electron theory-S. Raimes

Intermediate quantum mechanics-Bethe

Quantum mechanics-Landau &Lifshitz