

Course of Study

- **Preliminaries of Molecular Spectroscopy**

Interaction of light with matter; Time-dependent perturbation theory; Einstein Coefficients; Oscillator Strength; Transition dipole moment and selection rules; Line width and line shapes; Wave-packet : Free particle wave packet, Gaussian wave packet; Correlation Functions and Spectra; Fourier Transformation; Experimental aspects.

- **Atomic Structure and Spectroscopy**

H-atom and spectra; Angular Momentum and coupling of angular momenta; Term symbols; Zeeman Effect; Stark Effect; Spectra of many-electronic atoms.

- **Classical Molecular Spectroscopy**

Rovibrational: Rotational, vibrational and ro-vibrational spectroscopy of di-atomic and polyatomic molecules; Classification of rotors and selection rules; Polyatomic molecular vibrations; Local and normal modes; Infrared spectroscopy, selection rules; Rotational and vibrational Raman spectroscopy and selection rules. Electronic: Franck-Condon principle; Electronic spectroscopy; Selection rules; Walsh diagram and molecular geometry for AX_n systems; Vibrational progressions and geometry of excited states; Resonance Raman transitions and application; Radiative and nonradiative decay : internal conversion and intersystem crossing; Photo electron spectroscopy : UV-PES and XPS.

- **Spin Resonance Spectroscopy**

NMR spectroscopy; Origin of chemical shift and spin-spin coupling; Paramagnetic shifts; Relaxation processes; Nuclear quadrupole effects; NMR Imaging. EPR spectroscopy; Relaxation processes; Origin of g-shifts and hyperfine coupling; EPR spectra of free radicals.

- **Special Topics in Molecular Spectroscopy**

Principles of Mössbauer spectroscopy; Origin of isomer shifts; Quadrupole splitting; Principles and applications of Laser spectroscopy: Non-linear optics, Coherent non-linear spectroscopy, Multi-photon processes, LIF, CD spectroscopy, Femto-second spectroscopy; Wavepacket interferometry; Clocking chemical reactions; Optimal control theory for chemical reactions.

Books:

- Molecular Quantum Mechanics by Atkins and Friedman (OUP).
- Introduction to Quantum Mechanics: A Time Dependent Perspective by D. Tannor (Uni Sci Books).
- Molecules and Radiation by Steinfeld (Dover).
- Modern Spectroscopy by J. M. Hollas (Wiley).
- Fundamental of Molecular Spectroscopy by Banwell and Mc Cash (Tata McGraw-Hill).
- Molecular Structure and Spectroscopy by G. Aruldas (PHI).
- Molecular Vibration by Wilson, Decius and Cross (Dover).