

AA 615 / AA 415 : Quantum Mechanics and Spectroscopy**Instructors : Prakash Gaikwad (PG) and Mukul Bhattacharya (MB)****TA : Manish Singh Almia****L-T-P-C : 2-1-0-3****Scoring Structure:****Home Assignments + Attendance : 10 %****Quiz/Surprise Test : 20%****Mid-sem: 30 %****End-sem: 40 %**

Week	Instructor	Topics to be Covered
28 Jul - 31 Jul	PG	Basics of QM, Postulates of QM, Wavefunction, Operator, Schrodinger Equation, Particle in box and its applications to ISM Dust grains
03 Aug - 07 Aug	PG	The Simple Harmonic Oscillator (Frobenious Method) and its application to CO vibrational level.
10 Aug - 14 Aug	PG	Schrodinger equation in 3D, Infinite Spherical well Application: Electron trapped in white dwarf. CMB Photon inside “Box universe”
17 Aug - 21 Aug	PG	Hydrogen Atom : Radial and Angular Wavefunctions Application : Balmer, Lyman series lines
24 Aug - 28 Aug	PG	Tunneling: The WKB Approximation Nuclear Fusion in Stars, Alpha Decay in Radioactive Nuclei (Nucleosynthesis)
31 Aug - 04 Sep	PG	Quantum Mechanical Scattering Theory - I (Application to dust extinction in ISM)
07 Sep - 11 Sep	PG	Quantum Mechanical Scattering Theory - II (Application to Ly-alpha resonant scattering)
14 Sep - 17 Sep	PG	Variational Principle
18 Sep - 26 Sep	Mid-Sem	
28 Sep - 02 Oct		
05 Oct - 09 Oct	MB	Basics of Matric Mechanics, Bra-Ket Algebra, Hilbert spaces, Operators in linear vector spaces, projection

12 Oct - 16 Oct	MB	Hydrogen Atom : Angular Momentum, Spin (Pauli's Matrices)
19 Oct - 23 Oct	MB	Time-Independent perturbation Theory, Fine Structure and its application to fundamental constants
26 Oct - 30 Oct	MB	Stern-Gerlach Experiment, Zeeman Splitting, Application : Measurement of magnetic fields in sunspots, white dwarfs, or molecular clouds,
02 Nov - 06 Nov	MB	Hyperfine structure and its applications to 21cm line
09 Nov - 13 Nov	MB	Time Dependent Perturbation theory: Formalism Photoionization Cross Section of Hydrogen
16 Nov - 23 Nov	MB	Selection Rules, Implication to ISM Forbidden Lines in Nebulae, Hydrogen Recombination Lines. CO Rotational Transitions in Molecular Clouds
Nov 24 onwards	End Semester Exams.	

References:

1. Shankar, R., Principles of Quantum Mechanics, Springer, 2014, ISBN: 978-0306447907
2. Cohen-Tannoudji, C., Diu, B., Laloë, F., Quantum Mechanics, Volume 1: Basic Concepts, Tools, and Applications, Wiley-VCH,, 2019, ISBN: 978-3-527-34554-0
3. Feynman, R., Quantum Mechanics (Feynman lectures of physics vol. 3), Basic Books, 2011, ISBN:978-0465023820
4. Schiff, L.I., Quantum mechanics, McGraw-Hill, 2024, ISBN:978-0070856431
5. Sakurai, J. J., Modern Quantum Mechanics (2nd edition), Addison Wesley, ISBN:978-0805382914
6. Draine, B.T., Physics of Interstellar and Intergalactic Medium, Princeton University Press, 2011, ISBN: 9781400839087
7. Dyson, J.E., Williams, D.A., The Physics of the Interstellar Medium, CRC Press, 2020, ISBN: 9780367904234
8. Klessen, R.S., Glover, S.C.O., Physical Processes in the Interstellar Medium, 2016, Saas-Fee Advanced Course, arxiv:1412.5182