

# PHYSICS 312 — Syllabus

Spring 2015

Text: Townsend, *A Modern Approach to Quantum Mechanics* (University Science Books, 2nd Ed. 2012). Note: the 1st edition is perfectly fine as well

Brief review of key concepts and the Hydrogen-atom problem

Addition of Angular Momenta — Clebsch-Gordan Coefficients

Approximation Methods for Bound-State Problems.

Variational method.

Perturbation theory (time independent).

Degenerate case.

Zeeman effect without spin. Stark effect.

Fine Structure of Hydrogen

Relativistic kinematic correction.

Spin-orbit coupling.

Zeeman effect with spin.

Identical Particles

Bosons and fermions. Pauli Exclusion Principle.

Interaction between identical particles — exchange term.

Multielectron Atoms

Central-field approximation. Shell structure.

Corrections to central-field approximation. Hund's rules

Molecules

Ionic and covalent bonds.

Born-Oppenheimer approximation.

Vibration and rotation spectra.

Time-Dependent Perturbation Theory

General formalism. Harmonic case. Long-time limit.

Fermi's Golden Rule.

Interactions of atoms with classical electromagnetic fields.

Adiabatic approximation. Sudden approximation.

Scattering Theory

Born Approximation.

Partial waves. Phase shifts. Optical theorem.

Low-energy scattering: scattering length.

Mixed States and the Density Matrix

Brief introduction to Relativistic Quantum Physics

Relativistic wave equations. Klein paradox.

Free field theory. Quantized EM field; photons.