Classical and Quantum Mechanics 2

Part 2 of a two-semester sequence in the required graduate-level core curriculum covering the fundamentals of classical and quantum mechanics.

Instructor: Professor Aditi Mitra

Principal Textbooks:

“Modern Quantum Mechanics” (3rd Ed), Sakurai & Napolitano, Cambridge (2021)

“Principles of Quantum Mechanics”, R. Shankar, Plenum Press (2011)

Supplemental Text Books:

“Quantum Mechanics: Non-Relativistic Theory” (3rd Ed), Landau and Lifshitz, Elsevier Butterworth-Heinemann (2004)

“Lectures on Quantum Mechanics” (2nd Ed), Weinberg, Cambridge (2015)

Assignments: weekly problem sets based on the lectures listed below.

Exams: 1 midterm and 1 final

Assessment: 50% problem sets, 20% midterm exam, 30% final exam

Grading Scale: 100%-93% A, 92%-90% A-, 89%-87% B+, 86%-83% B, 82% - 80% B-, 79%-77% C+, 76%-73% C, 72% - 70% C-, 69%-67% D+, 66%-65% D, <65% F

Course Objectives

The goal of this course is to learn quantum mechanics and apply it to single particle or two particle systems. Students will be introduced to approximate methods which are very important for real world applications where exact solutions do not exist.

Course Schedule

Lectures 1 & 2: Rotation group, orbital and spin angular momentum, spherical harmonics (Sakurai 3.1-3.3, 3.5-3.6)

Lectures 2 & 3: Combining angular momentum, Clebsch-Gordon coefficients (Sakurai 3.8)

Lectures 4 & 5: Schrodinger equation in 3D, hydrogen atom (Sakurai 3.7,4.1.4)

Lectures 6 & 7: Identical particles, bosons and fermions, periodic table (Sakurai 7.1-7.5)

Lectures 8 & 9: Time-independent perturbation theory, Zeeman and Stark effects (Sakurai 5.1-5.2)

Lecture 10: Variational method (Sakurai 5.4)

Lectures 11 & 12: Time-dependent perturbation theory, sudden and adiabatic approximations, Fermi's golden rule (Sakurai 5.7)

Lectures 13 & 14: Interactions with electromagnetic radiation, Aharonov-Bohm effect, absorption and emission of radiation, Landau levels (Sakurai 5.8)

Lectures 15 & 16: Scattering theory, Lippman-Schwinger, scattering amplitudes (Sakurai 6.1-6.2.1)

Lecture 17: Born approximation (Sakurai 6.3)

Lectures 18 & 19: Phase shifts and partial waves, scattering cross-section (Sakurai 6.4.1-2)

Lecture 20: Unitarity and optical theorem (Sakurai 6.2.2,6.4.3)

Lectures 21 & 22: Time delay, resonances and bound states (Sakurai 6.6,6.7)

Lectures 23 & 24: Eikonal (WKB) approximation for scattering (Sakurai 6.5)

Lectures 25: Coulomb scattering (Weinberg 7.9)

Lectures 26-29: Overview, course summary and/or special topics