



UNIVERSIDAD COMPLUTENSE DE MADRID
DEPARTAMENTO DE FÍSICA TEÓRICA
GRADO EN FÍSICA

Quantum Physics I – Groups B & B2 – 2026/27

<http://teorica.fis.ucm.es/ft7/QP1.html>

Syllabus

1. Black body's radiation and the old quantum theory. Black body's radiation, Planck's hypothesis and Planck's law. The photoelectric effect and wave-particle duality. Compton scattering. The De Broglie hypothesis and the Davisson-Germer experiment. The double-slit experiment.

2. The Schrödinger equation and the wave function. Schrödinger's equation for a free particle. Schrödinger's equation for a particle in a potential energy field. The probabilistic interpretation of the wave function, The continuity equation and conservation of probability. Free wave packets and position's uncertainty.

3. Position, momentum and energy in quantum mechanics. The position expectation value and its time evolution. The momentum expectation value and its time evolution. The energy and the Hamiltonian. Commutation relations and uncertainty relations.

4. One-dimensional problems. Stationary states and the properties of their wave functions. Scattering states. The squared finite well. The step potential. The finite barrier. The squared infinite well. The harmonic oscillator. Other potentials.

5. An introduction to the mathematical formalism of quantum mechanics. A brief review/remainder on self-adjoint operators. The time independent Schrödinger equation as an eigenvalue problem. The space of the wave functions of a quantum system. Observables of a quantum system. Measurement in a quantum system and the state of the system after the measurement. Time evolution of a quantum system. Compatible observables.

6. A particle in a central potential. The Schrödinger equation for a two-body problem and its reduction. Angular momentum: definition, commutation rules and eigenstates (spherical harmonics). The radial time-independent Schrödinger equation. The Hydrogen atom.

Bibliografía

BASIC

- S. Gasiorowicz: *Quantum physics*, 3rd edition, John Wiley & Sons (Hoboken, NJ 2003).

- C. Sánchez del Río (coordinador), R. F. Alvarez-Estrada, J. L. Escudero, J. M. Guerra, P. M. Mejías, A. Muñoz, M. Ramón, J. L. Vicent y L. García: *Física cuántica*, 4th edition, Ediciones Pirámide (Madrid 2008).

SUPPLEMENTARY

- R. L. Liboff: *Introductory quantum mechanics*, Addison-Wesley Pub. Co. (Reading, MA 1980).
- D. J. Griffiths: *Introduction to quantum mechanics*, Prentice Hall (Upper Saddle River, NJ 1995).
- L. I. Schiff: *Quantum mechanics*, 3rd edition, McGraw-Hill (New York, NY 1968).

Goals

- To understand the description of states and observables in quantum mechanical systems.
- To understand the Schrödinger equation and its use in simple problems.

Grading

Midterm exam: Grade = MT.

Final exam: Grade = F.

The course's grade will be the result of using the following formula

$$\text{maximum } (0.3 \times \text{MT} + 0.7 \times \text{F}, \text{F}) .$$