

ADVANCED QUANTUM MECHANICS

[Juan Luis Mañes]

Relativistic quantum mechanics The Klein-Gordon equation. The Dirac equation. Coupling to electromagnetic fields. The limitations of RQM.

Path integrals Propagators as path integrals. Semiclassical approximation. The free particle and the harmonic oscillator. Infinite determinants.

The WKB method Connection with path integrals. Tunneling amplitudes. Bound states and Bohr-Sommerfeld quantization rules.

Coherent states and classical fields Harmonic oscillators and quantum fields. The classical limit. Particle creation by a classical source.

Landau levels Motion in a magnetic field. Momentum and velocity operators. Spectrum in a constant magnetic field. Coherent states. Landau levels and quantum Hall effect.

Berry's phase The adiabatic principle. Geometric phase and Berry's vector potential. Examples.

Introduction to quantum open systems Generalized measurements. Superoperators. The Lindblad equation. Coupling to a thermal bath of oscillators.

Bibliography

- R. Shankar, *Principles of Quantum Mechanics*, 2nd edition, Plenum Press 1994
L. I. Schiff, *Quantum Mechanics*, McGraw Hill 1968
K. Gottfried and T.-M. Yang, *Quantum Mechanics: Fundamentals*, 2nd edition, Springer 2003
C. Cohen-Tannoudji, *Quantum Mechanics*, 2nd edition, Wiley 1991
J. J. Sakurai, *Modern Quantum Mechanics*, Addison-Wesley 1994
M. Le Bellac, *Quantum Mechanics*, Cambridge U. Press 2012