Second Year Quantum Mechanics

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MT Lecture Synopsis

This is a summary of the material that I intend to cover during Michaelmas Term, together with an indication of which sections of the MT Problem Set are relevant.

1. **The Old Quantum Theory** The crucial experimental facts and what they tell us. The Planck-Einstein hypothesis that electromagnetic radiation has particle-like properties (photons). The de Broglie hypothesis that matter particles (eg, electrons, neutrons) have wave-like properties. Section 1 of the Problem Set.

2. **The Schroedinger Equation** The time-dependent Schroedinger equation and the probability interpretation of the wavefunction. Section 2 of the Problem Set.

3. **Bound States in a Box** Single particle in an infinitely deep square potential well. Quantized energy eigenvalues of the Hamiltonian H and associated bound-state eigenfunctions. Section 3 of the Problem Set.

4. **What are we really doing?** The general formalism of quantum mechanics. States, amplitudes, probabilities. Use of Dirac notation. Sections 4,5,6,7 of the Problem Set.

5. **Operators and Measurements** Physical quantities and hermitian operators and their eigenvalues. Measurements and reduction of the wavefunction. Expectation values of observables. Section 4 of the Problem Set.

6. **Conservation Laws** Conditions for the time-independence of expectation values. Commutators of operators. The local conservation of probability and the flux. Section 4 of the Problem Set.

7. **Measurements and the Heisenberg Uncertainty Principle** Sequences of measurements of different quantities. Heisenberg's Uncertainty Principle and non-commuting observables. Section 5 of the Problem Set.

8. **The Simple Harmonic Oscillator** Derivation of the spectrum of the SHO, and the low-lying eigenfunctions. Zero-point energy. The use of raising and lowering (creation and annihilation) operators to derive the spectrum. Section 6 of the Problem Set.

9. **Transmission Through Barriers and Wavepackets** Barrier penetration and transmission. Wavepackets and dispersion. Section 7 of the Problem Set.