

PHYS 443

Quantum Mechanics

Preliminary syllabus

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Course home page: <http://qis.ucalgary.ca/quantech/443/>

Chapter I. Linear algebra and postulates of quantum mechanics

- Linear spaces
- Basis, dimension
- Inner product. Hilbert space of physical states
- Orthonormal basis. Projective measurements. Quantum tomography
- Adjoint spaces
- Linear operators
- Operator observables. Eigenvalues. Diagonalization. Pauli operators
- Hermitian and unitary operators
- Commutator. Simultaneous diagonalization. Heisenberg's uncertainty
- Functions of operators
- Schrödinger equation

Appendix. Tutorial on optical polarizations

Appendix. Quantum cryptography (BB84)

Chapter II. Entanglement

- Tensor product of Hilbert spaces
- Entanglement. Partial measurements
- Quantum dense coding
- Remote state preparation
- Nonlocality
- No-cloning theorem
- Quantum teleportation

Chapter III. Motion of a particle

- Infinite dimension Hilbert spaces
- Momentum in the position representation
- Particle in a box (infinitely high potential barrier)
- Rectangular potential well; nuclear energy levels

- Harmonic oscillator. Vibrational molecular spectra
- Bound states in a Coulomb potential
- Free particle. Potential barrier, reflection and tunneling.
- Hydrogen maser (optional)
- Toy solid state model (optional)

Appendix. Fourier transformation

Appendix. Dirac delta-function

Chapter IV. Rotational motion

- Orbital angular momentum operators
- Rigid rotator. Rotational quantum numbers. Rotational molecular spectra
- Wavefunctions of the angular momentum eigenstates
- Spin
- Hydrogen atom (optional)
- Magnetic moment and magnetic field

Chapter V. Quantum physics of complex systems (optional)

- Density matrix
- Decoherence
- Schrödinger cats
- Critique of the Copenhagen interpretation
- Interpretations of quantum mechanics. Many-world theory