



## Summer School on Fundamental Notions of Quantum Information Theory

### Part I

#### Quantum Mechanics for Information Theory

22 June - 4 July 2009

Application deadline for Part I: 10 May 2009

Lecturers: Yusuf İpekoğlu, Sadi Turgut (METU)

#### Postulates of Quantum Mechanics

*Hilbert space, Dirac notation*

*base transformations, inner and outer products, matrix representation, eigenvalues and eigenvectors*

#### Two-Level Systems

*qubits, spin-1/2 systems, Bloch sphere, photon polarization,  
operators in quantum mechanics: unitary, projective, Hermitian and observable operators,  
spectral decomposition, no-cloning theorem*

#### Many Qubit Systems

*tensor product, representation in different bases, probability and probability amplitudes,  
density matrices and reduced density matrices, pure and mixed states, properties of density matrices,*

#### Quantum Entanglement

*Bell states and Bell inequalities*

*classical and quantum correlations, uncertainty relations, applications of quantum entanglement,  
teleportation, dense coding, super dense coding, cryptography, BB84 and E91 protocols,*

### Part II

#### Introduction to Quantum Information and Computation

10 - 23 August 2009

Application deadline for Part II: 13 July 2009

Lecturer: Zafer Gedik (Sabanci University)

#### Classical Information Theory

*entropy, relative entropy and mutual information, the asymptotic equipartition property,  
data compression, channel capacity,  
energy and information, reversible computation*

#### Quantum Information Theory

*quantum noise and quantum operations, distance measures for quantum information,  
quantum error correction, entropy and information, the Holevo bound, quantum cryptography*

#### Quantum Computing

*quantum circuits, universal quantum gates, quantum computational complexity,  
quantum circuit model of computation, simulation of quantum systems,  
physical realization of quantum computers*

#### Quantum Algorithms

*quantum parallelism, the Deutsch-Jozsa algorithm, the quantum Fourier transform,  
Shor's factorization and RSA cryptography, the Grover search algorithm*