

Quantum information I

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Instytut Fizyki PAN, **Tuesdays, 13:30-15:30**

First lecture on **February 25th 2025**

Course website: <http://info.ifpan.edu.pl/~lcyw/wyklady/quantum-information-processing/>

Plan of the course:

1) A quick refreshing of quantum mechanics

Pure states. Dirac's notation. Scalar product. Hermitian operators, eigenstates. Spectral decomposition. Projective measurements. Unitary evolution. Two-level systems: qubits.

2) Elements of spin resonance theory.

Rabi oscillations. Coherent control over a qubit.

3) Quantum composite systems.

Tensor product. Entanglement of pure states.

4) Mixed states and more general measurement theory.

Reduced density matrix. Von Neumann's entropy of a reduced state of a subsystem. Measurements on entangled subsystems. Entanglement of mixed states.

5) Bell inequalities, no-cloning theorem, quantum cryptography, quantum teleportation.

6) Interactions between qubits.

Generation of entanglement.

7) Decoherence

Basic examples. Dephasing and relaxation.

8) Elements of classical information theory and algorithmic complexity.

Algorithms, Turing's machines, Turing's theses, examples of algorithmic complexity classes (P, NP, etc).

9) Information processing and physics.

Classical bits vs qubits. How is quantum computer supposed to work? Quantum logic gates.