1 Introduction to Quantum Control Theory

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Aim: The objective of the course is to present the basic techniques and notions of the theory of control and analysis of quantum dynamics using a Lie algebraic approach. At the end of the course the students will have an elementary knowledge of quantum mechanics and will be able to analyze dynamics of quantum control systems in particular for what concern their controllability. They will be able to design control algorithms for quantum systems and analyze several examples including nuclear magnetic resonance experiments and implementations of information processing.

Topics:

1. Brief introduction to quantum mechanics. States, operators and dynamics of quantum systems. Evolution as quantum information processing.
2. Introduction to Lie algebras and Lie groups. Lie transformation groups in connection with quantum dynamics.
3. Controllability of quantum experiments. Tests of controllability for the state, the evolution operator and the density matrix. Decomposition of quantum dynamics.
4. Survey of methods to control quantum systems. Lie group decompositions, Optimal control, Lyapunov control, Adiabatic Control.
5. Examples of applications. Nuclear magnetic resonance, implementation of quantum information processing, quantum walks.

References: D. D'Alessandro, *Introduction to Quantum Control and Dynamics*, CRC Press, Boca Raton, FL, 2007.

Time table: 8 Lectures of 1.5 hours each.

Course requirements: Basic knowledge of algebra, linear algebra and differential equations. Basic notions of control theory.