Quantum dynamics and control of open quantum system

3 CFU

Teaching staff

Name Surname: Elisabetta Paladino

Email: elisabetta.paladino@dfa.unict.it

Office: DFA 318

Reception hours: Wednesday 15-17; Friday 11-13

Program of the course:

The course focuses on the dynamics of quantum systems interacting with enviromental degrees of freedom modelling either a classical system or another complex quantum system. Any quantum system unavoidably interacts with its surroundings, as a result intrinsically quantum features as quantum coherence and entanglement are degraded. Recently, the resulting phenomenon of decoherence has attracted a great deal of interest in the field of quantum information where the quantum dynamics of two-state systems need to be accurately controlled to achieve specific tasks. In the present course, mathematical approaches of the theory of open quantum system we be introduced: Kraus representation theorem, amplitude-damping and phase-damping, Markov approximation, Master Equation, Lindblad equation, Redfield-Born theory of relaxation, non-Markovian noise, Stochastic Liouville equation and cumulants, stochastic wavefunctions. The path-integral approach to deal with quantum systems interacting with a bosonic quantum bath will be introduced. By using the appropriate approach two issues of both fundamental and applicative importance in physics will be addressed: the fragility of macroscopic quantum superpositions (Schrödinger cat states) and the deterioration of entanglement. These two aspects are crucial both for understanding fundamental features of quantum theory, such as the quantum measurement problem and the quantum-classical border, and for new quantum technologies such as quantum computation and communication.

Bibliography:

U. Weiss, Quantum Dissipative Systems, World Scientific (2012);

H. P. Breuer, F. Petruccione, The Theory of Open Quantum Systems, Oxford University Press (2002)