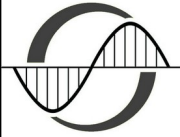




UNIVERSITÀ
degli STUDI
di CATANIA



DIPARTIMENTO DI FISICA E ASTRONOMIA
“ETTORE MAJORANA”

DOTTORATO DI RICERCA IN FISICA
CICLO XLII A.A. 2026/2027

Quantum dynamics and control of open quantum system

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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 environmental degrees of freedom modelling either a classical system or quantum mechanical. 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 and technologies 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.

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)