Corso di Laurea Specialistica in Scienze Fisiche
a.a. 2007-2008
Decoerenza quantistica ed emergenza del comportamento classico dalla Meccanica Quantistica
Titolare: Professore Hans-Thomas Elze

Programma.
(Corso di 32 h)

I. Introduction - Why study decoherence?

The "classical limit" as presented in the textbooks: correspondence principle; Ehrenfest theorem; wave packets and cloud/bubble chamber tracks; WKBJ approximation; large quantum numbers. ("Decoherence from quantum information to quantum gravity.")

II. Density Matrices and Wigner Functions

Pure/mixed states; von Neumann equation; properties of Wigner functions; Vlasov/Boltzmann equations; open systems; von Neumann entropy; decoherence and entropy growth.

III. Fundamental Energy Decoherence

Models of Penrose (space-time fluctuations), Diosi (uncertainty of Newtonian gravitational field), Milburn (Planck time), Adler (pre-quantum dynamics); experiment proposed by Penrose et al.

IV. Density Matrices for Bi-partite Systems

Schmidt decomposition; decoherence vs. interference; entanglement entropy; Mermin's SSC theorem; Gleason's theorem.

V. Entanglement Effects on Dynamics

Quantum Zeno effect; interplay of evolution/measurements/interference; Measurement Problem; no-cloning theorem; Zeno effect in two-state systems; Wineland et al. experiment; counterfactual/non-demolition measurements; (Elitzur et al., Zeilinger et al.); decoherence of macroscopic objects and Schroedinger cats.

VI. Methods of Decoherence Control

Fermi's Golden Rule and time-dependent interactions; open systems in weak-/strong-coupling regime; "bang-bang" techniques; decoherence free subspaces.

VII. Path Integral Derivation of Master Equations

Feynman-Vernon influence functional; Ohmic environment and Markovian limit; Fokker-Planck equation.

VIII. Special Topics

Gell-Mann and Hartle decoherent histories formulation of quantum mechanics ("spacetime quantum mechanics"); deterministic models of quantum mechanical systems.

IX. Literature: textbooks on quantum mechanics, for example

D.S.Saxon, Elementary Quantum Mechanics, (McGraw-Hill, New York, 1963?);
E.Merzbacher, Quantum Mechanics, 2nd edition (J.Wiley, New York, 1970);
L.S.Schulman, Techniques and Applications of Path Integration (J.Wiley, New York, 1981).

A detailed list of recent articles related to the course will be given to the students, who are expected to have a knowledge of QM.