Institut de Physique Théorique

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A quick introduction to the quantum formalism

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*Les vendredis 4/5/2012, 11/5, 1/6 à 10h00 et le **mardi** 15/5 à 14h15.*

Quantum mechanics - and its relativistic version: quantum field theory (QFT) - is immensely successful and unrivaled since 80 years. Yet its principles and its seemingly paradoxical aspects are further tested, and actively discussed and commented. The goal of these lectures is to present an introductory but hopefully coherent view of the main formalizations of quantum mechanics, of their interrelations, and of their theoretical foundation. The course is aimed at a non-specialized audience: graduate students and more advanced researchers, not necessarily theorists. The mathematical formalism will be presented and discussed at a simple and not-too-abstract level. This course will not attempt to cover the historical and philosophical aspects of quantum physics. The tentative plan of the lectures follows.

  1 – Reminders:
   • Classical mechanics: states, observables & probabilities
   • The canonical and path integral formulations of quantum mechanics & QFT
   • Causality, reversibility & locality

 2 - Algebraic quantum theory
   • The algebra of observables
   • States & real C*-algebras
   • The GNS constructions, complex Hilbert spaces
   • Algebraic QFT & von Neumann algebras

 3 - «Quantum logic» formulations
   • The lattice of propositions & orthomodular geometry
   • Soler's & Gleason's theorems, Hilbert spaces (again)

 4 - Quantum information (operational) formulations

 5 - A few words (depending on time) on:
   • Quantum correlations: causality, non-localities and contextuality
   • Quantum measurements & the quantum-to-classical transition
   • Interpretations of quantum mechanics versus alternative quantum theories
  … to say nothing of quantum gravity …