universität innsbruck

Department of Theoretical Physics

Theory Colloquium

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"Probing new physics with open quantum systems"

Abstract

Dark matter and dark energy constitute two of contemporary physics' greatest open problems. Some of the most accredited solutions suggest new physics in the form of yet undiscovered particles and fields beyond the standard models of particles and cosmology. In order to detect such particles, there are increasing efforts to establish high-precision, low-energy quantum experiments as complements to colliders. To fully harness the potential of such experiments, we must be able to describe the quantum dynamics of probe systems with a theoretical accuracy comparable to that of the mathematics used for colliders. Consequently, there is an urgent need to develop methods capturing quantum information concepts in quantum field theory (QFT) and to understand how QFTs can be tested in non-relativistic quantum devices. In this talk, I address this demand by presenting a tractable path-integral-based formalism for directly computing density matrices for closed and open systems in QFT. It requires only a very few assumptions and can even describe non-Markovian dynamics. The formalism is based on established techniques from non-equilibrium QFT, including the Schwinger-Keldysh formalism and thermo field dynamics. Using results obtained with this formalism, I will discuss the potential of employing open quantum systems as probes in the search for a selected class of new physics models that have extensively been searched for with tabletop experiments.

Wednesday | 29.04.2026 | 5:00pm

SR 1 | ICT building