FONDAZIONE BRUNO KESSLER

ECT*
EUROPEAN CENTRE
FOR THEORETICAL STUDIES
IN NUCLEAR PHYSICS AND RELATED AREAS

PhD SEMINAR

Wednesday, October 14th 2026, at 15.00

ECT*, Aula Leonardi, Strada delle Tabarelle 286, Villazzano

Quantum Gravity Signatures in Precision Experiments by Testing Pauli Exclusion Principle in Underground Experiments

Catalina Curceanu

INFN, Laboratori di Frascati

Quantum mechanics provides an extraordinarily successful description of Nature, yet its conceptual foundations remain incomplete when confronted with gravity. Several approaches to quantum gravity predict modifications of standard quantum principles, including deformations of the uncertainty principle, spacetime fuzziness, intrinsic decoherence effects, and possible tiny violations of the Pauli Exclusion Principle (PEP). Precision low-energy experiments offer a unique window into physics beyond the Standard Model and beyond standard quantum mechanics.

In this talk, I will present a program of underground experiments at the Gran Sasso National Laboratory and other underground labs aimed at probing quantum-gravity-inspired deviations from standard quantum theory. Particular emphasis will be placed on searches for violations of the Pauli Exclusion Principle performed by the VIP experiment, which reaches unprecedented sensitivity through ultra-low-background X-ray spectroscopy. Such searches can be interpreted not only as tests of a fundamental symmetry principle, but also as probes of generalized quantum frameworks connected to the Generalized Uncertainty Principle (GUP), noncommutative geometries, and quantum-gravity-induced modifications of spacetime structure.

Connections between PEP tests, gravity-induced decoherence, and collapse models such as Continuous Spontaneous Localization (CSL) will also be addressed, highlighting possible common origins in quantum gravity phenomenology.

I will present current results, future experimental perspectives, and the broader role of precision underground measurements in exploring the interface between quantum mechanics and gravity. It aims to stimulate discussion on how table-top and low-energy experiments can contribute to answering some of the deepest questions about the fundamental structure of reality.

Director of ECT*: Prof. Ubirajara van Kolck

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