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High Sensitivity Quantum Mechanics tests in the Cosmic Silence

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The VIP experiment aims to perform high sensitivity tests of the Pauli Exclusion Principle (PEP) for electrons, and look for a possible small violation.
In Local Quantum Field Theories approach any PEP violating transition is strongly constrained by the Messiah Greenberg Superselection (MGS) rule, which forbids superpositions of states with different symmetry. Such models can then be only tested with open systems. This condition is realised in VIP-2 by introducing "new"electrons in a pre-existing system of electrons, and then testing the resulting symmetry state. The data analyses results from the newest VIP-2 Open Systems data taking will be presented.
It was recently shown that a large class of Quantum Gravity models embeds the violation of PEP, violating the MSG rule, as a consequence of the space-time non-commutativity. High sensitivity tests of PEP violation in closed systems turn then to be the better candidates to put strong experimental limits on the energy scale of the non-commutativity emergence in Quantum Gravity. The results of exploratory studies based a High Purity Germanium (HPGe) Detecors and high radio-purity Roman Pb targets will be shown.

The extremely low background environment of LNGS is also suitable for investigating one of the main mysteries of Quantum Mechanics Foundations: the measurement problem. Collapse models propose phenomenological solutions to the measurement problem; by modifying the linear and unitary evolution of the Schroedinger equation adding a non-linear term and the interaction with a stochastic noise field. Collapse models account for the wave function collapse in space, which is characterised by an amplification mechanism, the biggest the mass the faster the reduction of the wave packet. The quantum to classical transition is then realised by ensuring that macroscopic objects always have well defined positions. On the other hand the interaction with the noise field is very small at the microscopic level, where the standard Schroedinger evolution dominates. The results of our analyses, setting the strongest constrains on collapse models, will be presented.

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