Contribution ID: **75** Type: **Oral contribution**

Testing Quantum Mechanics and the Nature of Gravity through Diffusion

Tuesday 8 July 2025 17:50 (20 minutes)

Is gravity fundamentally quantum, like the other three fundamental interactions, or is it classical? Could gravity play a fundamental role in wave function collapse, as suggested by models such as the Diósi–Penrose (DP) model? These questions remain open.

Many proposed experiments aimed at addressing these questions rely on creating spatial superpositions of large masses. For instance, tests of gravity's quantumness—such as the Bose–Marletto–Vedral (BMV) protocol—seek to detect entanglement between two masses in spatial superposition. Similarly, interferometric experiments with large-mass superpositions have been suggested for testing the DP model, which predicts position-dependent collapse. However, creating and maintaining such large-mass superpositions remains extremely challenging.

In this talk, I propose an alternative strategy. Both classical gravity and the DP model predict a minimum, unavoidable amount of diffusion. This opens the possibility of testing these proposals without needing large-mass superpositions, by instead looking for their characteristic diffusive effects. This approach has already proven successful in the context of the DP model, allowing the parameter-free version of the model to be ruled out. I will present this result in detail and discuss how similar experimental strategies can be extended to test the quantum vs classical nature of gravity.

Working Group

WG3 - Low-energy gravitational effects in quantum systems

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Session Classification: WG3 Low-energy Gravitational Effects in Quantum Systems 1