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Can Neutrinos Hear the Echoes of Quantum Spacetime?

Open-System Decoherence in Neutrino Oscillations

Dr Partha Nandi (NITheCS)

Friday, 29 May 2026 @ 14h00-15h00 SAST

Venues: NITheCS Seminar Room, Stellenbosch University; and Online

ABSTRACT

In this talk, I will discuss an open-quantum-system framework in which quantum spacetime acts as an effective environment inducing decoherence in neutrino oscillations. Within the κ-Minkowski noncommutative spacetime framework, Planck-scale fluctuations are modelled as stochastic noise, leading naturally to a Lindblad-type master equation.

As an application, I will show that quantum-spacetime fluctuations generate a distinctive decoherence behaviour with inverse-energy scaling, $\Gamma \propto E^{-4}$, predicting strong suppression of decoherence at high energies, consistent with IceCube observations, while enhancing possible effects in the low-energy regime.

The results establish a connection between quantum spacetime, open quantum dynamics, and neutrino phenomenology, suggesting a novel route toward probing quantum gravity through decoherence effects.

BIOGRAPHY

Dr Partha Nandi is a theoretical physicist specialising in the interface between quantum mechanics and gravity. He completed his PhD in 2022 at the S. N. Bose National Centre for Basic Sciences, Kolkata, India, where he developed a strong foundation in quantum field theory, general relativity and the foundational aspects of quantum theory. He then joined Stellenbosch University as a postdoctoral fellow, where he worked for two years on the quantum aspects of gravitational phenomena. He subsequently continued his research as a postdoctoral research Associate at NITheCS.

His research focuses on uncovering the quantum nature of spacetime, with particular emphasis on gravitational waves as a potential observational window into quantum gravity. He investigates phenomena such as gravity-induced decoherence, entanglement generation, and the behaviour of quantum systems interacting with dynamical spacetime backgrounds.

His work aims to bridge the gap between abstract formulations of quantum gravity and physically testable scenarios, providing new insights into how quantum coherence and correlations manifest in gravitational settings. In parallel, he is committed to teaching and mentoring, with a strong emphasis on conceptual clarity and the rigorous development of formalism.

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