Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Contribution ID: **3159** Type: **Oral (Non-Student) / Orale (non-étudiant(e))**

The gravitational field of a non-local superposition

Thursday 9 June 2022 09:45 (15 minutes)

In a non-local quantum superposition of a massive particle, does the gravitational field behave as the classical superposition of two particles separated by a spatial distance with half the mass located at each position or does the system behave as a quantum superposition with a far more interesting and subtle behaviour? We compute the differential scattering cross-section under the interaction coming from the exchange of one graviton. We find that the scattering cross-section is not remotely represented by the classical picture, of potential scattering from two localized sources with half the mass at each source. We discuss how this result compromises the Newton-Schrödinger description of gravitation interacting with quantum matter.

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Session Classification: R1-2 Gravity and Cosmology II (DTP) | Gravité et cosmologie II (DPT)

Track Classification: Technical Sessions / Sessions techniques: Theoretical Physics / Physique théorique (DTP-DPT)