

Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: 206 Type: Oral not-in-competition (Graduate Student) / Orale non-compétitive (Étudiant(e) du 2e ou 3e cycle)

## Simulating a superposition of spacetimes with optical media

Monday 9 June 2025 14:30 (15 minutes)

Under certain conditions, an arbitrary spacetime can be modelled as an equivalent optical medium characterized by properties such as permittivity, which modifies the speed of light propagation and, consequently, the structure of light cones. To explore quantum effects in this context, we investigate the evolution of a single electromagnetic field mode in a cavity where the permittivity depends on the state of a control qubit, creating a superposition of permittivities.

By measuring the control qubit along a superposition basis rather than tracing over its Hilbert space, we imprint the effects of the superposition on the electromagnetic field mode. We derive an analytical expression for the probability of measuring the control qubit in a superposition state as a function of two constant permittivities, revealing how a quantum superposition of optical properties affects the electromagnetic field mode dynamics.

By showing how a superposition of permittivities influences field dynamics, this work represents an early step toward simulating a quantum superposition of spacetimes in the lab using optical media.

## Keyword-1

analogue gravity

## Keyword-2

superposition of spacetimes

## Keyword-3

**Authors:** PRECIADO-RIVAS, María Rosa (University of Waterloo); TOBAR, Germain (Stockholm University); ZYCH, Magdalena (Stockholm University)

Presenter: PRECIADO-RIVAS, María Rosa (University of Waterloo)

**Session Classification:** (DTP) M2-10 Quantum Systems II / Astrophysics of Compact Objects | Astrophysique des objets compacts (DPT)

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