Contribution ID: **65** Type: **Talk**

Quantum Transparency of Near-extremal Black Holes

Friday 10 October 2025 10:30 (9 minutes)

We investigate the scattering of electromagnetic and gravitational waves off a Reissner-Nordström black hole in the low-temperature regime where the near-horizon throat experiences large quantum fluctuations. We find that the black hole is transparent to electromagnetic and gravitational radiation of fixed helicity below a certain frequency threshold. This phenomenon arises because the angular momentum of the black hole is quantized, creating an energy gap between the spinless black hole state and the first excited spinning states. Radiation with angular momentum—such as photons, gravitons, and partial waves of a massless scalar field, which we also study—must supply enough energy to bridge this gap to be absorbed. Below this threshold, no absorption can occur, rendering the black hole transparent. For frequencies above the gap, the scarcity of black hole states continues to suppress the absorption cross-section relative to semiclassical predictions, making the black hole translucent rather than completely transparent. Notably, electromagnetic absorption is significantly stronger than gravitational absorption, beyond what differences in spin alone would suggest.

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Session Classification: Morning talks