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From black hole's atmosphere to thermal quenches : probing the gravitational anomaly in quantum materials

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Einstein famously argued that energy has mass, which distorts spacetime. Conversely, as spacetime distorts, the energy density varies. This classical phenomenon applies even to massless particles: their thermal energy must vary in an inhomogeneous spacetime. The latter observation underlies an equivalence between a slowly varying temperature profile and a weakly curved spacetime. This equivalence, proposed by Luttinger, is at the core of the formalism describing the heat current generated by a varying temperature.

In this talk, I will show that this useful equivalence neglects quantum fluctuations induced by a strong curvature of spacetime, or equivalently large local variations of temperature.
Upon increasing this curvature, these quantum fluctuations alter the energy conservation, a phenomenon known as the gravitational anomaly of relativistic quantum field theories.
Taking into account such fluctuations is essential to describe the heat current close to a black hole. The recent advent of quantum material with relativistic low energy excitations offer new perspectives to probe such exotic properties in a laboratory. I will discuss new experimental routes to probe these elusive curvature-induced quantum effects in a laboratory.

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