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Analogue quantum simulation of the Hawking effect with a polariton superfluid

Analogue Gravity is a type of analogue quantum simulation that aims at observing effects initially predicted by quantum field theory on curved spacetime, such as the Hawking effect and rotational superradiance, in systems at laboratory scales with similar dynamics [1].

The high tunability of such systems enables to shed light on phenomena that are either currently eluding our comprehension or simply unreachable by their very nature. As such, analogue systems are the theater of rich physics coming from both condensed matter and quantum fields on curved spaces that yield many interesting crossovers in the physical interpretations.

I will present our recent results on the investigation of the Hawking effect in a quantum fluid of polaritons based on the knowledge that the basic process at the heart of the Hawking effect leads to the emission of sound waves from the sonic horizon in a transsonic fluid flow [2].

I will also discuss the potential of this platform to observe new phenomena resulting from vacuum fluctuations at the horizon [3], namely the modification of the Hawking spectrum by relaxation of the horizon after perturbation. This is an outstanding question in black hole physics on which analogue quantum simulations provide a new perspective.

[1] W. G. Unruh, Experimental Black-Hole evaporation? Phys. Rev. Lett. 46, 1351 (1981)
[2] M. Jacquet et al., Analogue quantum simulation of the Hawking effect in a polariton superfluid. Europ. Phys. Jour. D 78 152 (2022)
[3] M. Jacquet et al., Quantum Vacuum excitation of a quasinormal mode in an analogue model of black hole spacetime. Phys. Rev. Lett. 130 111501 (2023)

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