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The information loss problem: an analogue gravity perspective

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Analogue Gravity can be used to reproduce the phenomenology of Quantum Field Theory in Curved Spacetime and in particular phenomena such as cosmological particle creation and Hawking radiation.
In black hole physics, taking into account the backreaction of such effects on the metric requires an extension to semiclassical gravity and leads to an apparent inconsistency in the theory: the black hole evaporation induces a breakdown of the unitary quantum evolution leading to the so called information loss problem. Here we show that, albeit the back reaction in analogue systems is not described by semiclassical Einstein equations, analogue gravity can provide an interesting perspective on the resolution of this problem. In particular, by looking at the simpler problem of cosmological particle creation, we show, in the context of BEC analogue gravity, that the emerging analogue geometry and quasi-particles have correlations due to the quantum nature of the atomic degrees of freedom underlying the emergent spacetime. As a consequence the quantum evolution is always unitary on the whole Hilbert space which cannot be exactly factorised a posteriori in geometry and quasi-particle components.
In analogy, in a black hole evaporation one should expect a continuous process creating correlations between the Hawking quanta and the microscopic quantum degrees of freedom of spacetime, implying so that only a full Quantum Gravity treatment would be able to resolve the information loss problem by proving the unitary evolution on the full Hilbert space.

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