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Quantum effects in gravity from a delocalised quantum source

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Understanding the fundamental nature of gravity at the interface with quantum theory is a major open question in theoretical physics. Recently, the study of gravitating quantum systems, for instance a massive quantum system prepared in a quantum superposition of positions and sourcing a gravitational field, has attracted a lot of attention: quantum optics experiments are working towards realising such a scenario in the laboratory, and measuring the gravitational field associated to a quantum source is expected to give some information about the nature of gravity. On the theory side, quantum information tools are used to interpret the results. However, there are still open questions concerning the precise conclusions that these experiments could draw on the quantum nature of gravity, such as whether experiments in this regime will be able to test more than the Newtonian part of the gravitational field.
In my talk, I will present a new result, where a delocalised quantum source gives rise to effects that cannot be reproduced using the Newton potential nor as a limit of classical General Relativity. These effects can in principle be measured by performing an interference experiment, and are independent of graviton emission. Identifying stronger quantum aspects of gravity than those reproducible with the Newton potential is crucial to prove the nonclassicality of the gravitational field and to plan a new generation of experiments testing quantum aspects of gravity in a broader sense than what proposed so far.

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