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Quantum systems as gravitational sources: theory-independent and theory-specific predictions on the nature of gravity

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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: 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 quantum aspects of gravity. However, there are still open questions concerning the precise conclusions that these experiments could draw on the nature of gravity.

In this talk, I will argue that a full answer to this question requires two different approaches: on the one hand, a theory-specific description that identifies precise effects that cannot be explained by classical gravity; on the other hand, a theory-independent description, inherited from Bell's theorem, that tests the internal consistency of the theory and constrains from first principles which scenarios are compatible with a classical nature of gravity and which ones are not.

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