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PLENARY: Quantum Interference of "Clocks"

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Abstract content
   (Max 300 words)

Experimental tests of general relativity performed so far involve systems that can be effectively described by classical physics. On the other hand, observed gravity effects on quantum systems do not go beyond the Newtonian limit of the theory. In light of the conceptual differences between general relativity and quantum mechanics, as well as those of finding a unified theoretical framework for the two theories, it is of particular interest to look for feasible experiments that can only be explained if both theories apply. We propose testing general relativistic time dilation with a single "clock" in a superposition of two paths in space-time, along which time flows at different rates. We show that the interference visibility in such an experiment will decrease to the extent to which the path information becomes available from reading out the time from the "clock". This effect would provide the first test of the genuine general relativistic notion of time in quantum mechanics. We consider implementation of the "clock" in evolving internal degrees of freedom of a massive particle and, alternatively, in the external degree of a photon and analyze the feasibility of the experiment. More details can be found:

M. Zych, F. Costa, I. Pikovski, T. C. Ralph and Č. Brukner, General relativistic effects in quantum interference of photons, Class. Quantum Grav. 29 224010 (2012)

M. Zych, F. Costa, I. Pikovski, Č. Brukner, Quantum interferometric visibility as a witness of general relativistic proper time, Nature Communication 2:505 doi: 10.1038/ncomms1498 (2011)

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