Weak measurement and quantum gravity

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The idea that a particle trajectory has no meaning in quantum mechanics has been called into question by the experimental work of Kocsis et al [1] based on weak values [2]. The conventional view has been unambiguously stated by Landau and Lifshitz [3] :- "In quantum mechanics there is no such concept as the path of a particle". In contrast, a basic concept in General Relativity is the geodesic. Reconciling these two views has been one of the stumbling blocks to producing a quantum theory of gravity. A detailed examination of the weak value of momentum shows a close correspondence to the transition probability amplitudes that play a central role in the Schwinger-Feynman approach to QM and QFT [4].

The first experimental programme to observe weak values in atomic systems is currently being carried out at UCL. Specifically we are measuring the weak value of spin for helium and it is proposed to continue the measurements using argon, neon and xenon gases. This is the first time the weak measurement technique will have been demonstrated using atoms. Not only will this be a world first but it may open the way to new kinds of measurement on individual atoms. The student following an experimental PhD will continue these experiments.

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References

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