Joint Quantum Sciences Seminar

Wednesday, September 26, 4:00 pm
Jefferson 250

Margaret D Reid

Swinburne University of Technology, Melbourne Australia

“Mesosopic Einstein-Podolsky-Rosen states of massive systems”

The demonstration of long-lived entanglement between two separated massive systems opens up the possibility of new tests of quantum mechanics and decoherence theories. For example, the intriguing idea of spatially dependent decoherence was put forward by Furry [1] in response to Einstein-Podolsky-Rosen’s (EPR) paradox paper [2], which highlighted the inconsistency of quantum mechanics with the classical premise of local realism. Furry’s hypothesis is not a part of conventional quantum mechanics. It could occur in a modified quantum mechanics. In the EPR paradox, a measurement made by an observer at one location can seemingly instantaneously affect the quantum state at another. States that demonstrate the correlations of an EPR paradox were thus called “steerable” by Schrodinger. Here, we will present evidence for EPR steerable entangled states of 40,000 atoms generated in a Bose-Einstein condensate [3]. The structure of the correlations can be further analysed, to deduce miniature cat-type paradoxes with atoms. In order to investigate EPR steerable states with spatial separations, we present a protocol for creating, storing and retrieving EPR steerable states of an opto-mechanical oscillator [4]. This leads us to consider the possibility of generating mechanical Schrodinger cat-states, and to test macroscopic realism for massive systems using Leggett–Garg and Bell inequalities in time.

Peter D Drummond

Swinburne University of Technology, Melbourne Australia

“Simulations of many-body systems: Furry and Coleman revisited”

Wendell Furry [1] and Sydney Coleman [5] were two of Harvard's most original quantum theorists. What can modern technology contribute to their work? Experimentally tested simulations of opto-mechanics[4] and atom interferometers [3], with thermal noise and losses, will be used to analyse proposals for testing Furry's nonlocal decoherence, and Coleman's QFT tunnelling to the true vacuum. Both entanglement decoherence and massive Schrodinger cats are testable [4] through an optomechanical memory, simulated using the positive-P representation. Coleman's vacuum tunnelling idea will be applied to construct a proposal for a laboratory model of the quantum fluctuations in the 'Big Bang', using a coupled BEC experiment simulated with a Wigner representation [6].

Who needs a ship in a bottle, when you can have a universe on table-top?

[1] W. H. Furry, Phys. Rev. **49**, 393 (1936). [2] A. Einstein, B. Podolsky, and N. Rosen, Phys. Rev. **47**, 777 (1935). [3] M. Egorov et. al, Phys. Rev. A **84**, 021605 (2011). [4] S. Kiesewetter, R. Y. Teh, P. Drummond and M. Reid, Phys. Rev. Lett. **119**, 023601 (2017). [5] S. Coleman, Phys. Rev. D **15**, 2929 (1977). [6] O. Fialko et. al., J. Phys. B **50** 024003 (2017).

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