Bell non-locality in macroscopic systems

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Focusing on bipartite systems, a brief review will be given of categorizing quantum states as either separable or entangled [1], or alternatively as Bell local or Bell non-local states based on local hidden variable theory (HVT) [2]. Various sub-categories of states display different features regarding EPR steering and Bell non-locality [2]. Finding states that are Bell non-local has long been recognised as important in regard to the long standing controversy between the Copenhagen quantum interpretation of the measurement process involving "collapse of the wave-function" and the alternative interpretation based on pre-existing hidden variables. Although experiments demonstrating Bell non-local in microscopic systems have now been carried out [3], there is current interest in finding Bell non-locality in quantum systems on a macroscopic scale, since in this regime a HVT might be expected to apply. Theoretical approaches towards finding macroscopic quantum states that violate Bell inequalities (such as in [4-8]) will be reviewed. A new test for Bell non-locality [9] applying when the sub-system measured quantities are spin components with large outcomes will be described, and applied to four mode systems of identical massive bosons in Bose-Einstein condensates.

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