

CSU PHYSICS COLLOQUIUM

“Can we reinvent the neutron as an entangled quantum probe?”

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Abstract

A defining feature of quantum mechanics is the phenomenon of entanglement whereby, as Schrodinger put it, “The best possible knowledge of the whole does not necessarily include the same for its parts”. The phenomenon is the basis for what some have called the second quantum revolution that will eventually lead to ubiquitous quantum computing and secure communications. While the entanglement of “particles” such as photons, is fairly well known, the notion of entangled subsystems of a quantum particle – such as its spin, energy, path or angular momentum – has received less attention. In this talk, after a heuristic introduction to the phenomenon of entanglement, I will describe some experiments in which the spin, momentum and total energy of an individual neutrons have been entangled. The experiments rely on a calculation that use experimentally measured quantities to derive so-called contextuality witnesses whose values must exceed given bounds if quantum variables are entangled. Now that we have demonstrated entanglement, our eventual goal is to develop entangled neutrons as a probe of materials, perhaps with the ability to measure the state of entanglement of electrons in matter. If successful, such a probe might contribute strongly to our understanding of quantum materials for future technologies.

Biography

- PhD from Cambridge University in 1969 under the tutelage of Dr. Gordon Squires, one of the pioneers of neutron scattering
- Employed at various times by neutron scattering facilities in 5 countries (UK, Sweden, Norway, France, USA); carried out neutron experiments in 4 more countries
- Research interests over the years have included structural phase transitions, low-dimensional magnetism, complex fluids, neutron instrumentation
- 13 years as a manager of scientific facilities and research at Los Alamos National Lab
- Currently a professor at Indiana University in Bloomington with a joint faculty appointment at Oak Ridge National Lab
- Fellow of the APS, AAAS and NSSA; Gunnar Randers prize (presented by HRH King of Norway)