Kurzfassung

Kandidat: Armin Danner

Prüfer: Yuji Hasegawa, Markus Arndt, Wolfgang Treimer

Titel: Which-Way Experiments with a Three-Path Quantum Cheshire Cat & Simultaneous Weak-Path Measurements in Neutron Interferometry

Weak values are defined for a procedure with a pre-selected and a post-selected state. Weak values are the result of weak measurements, where a weak interaction is applied in between pre- and post-selection. The interaction entangles a system observable with a meter. In this thesis, two experiments in neutron interferometry are presented which use weak values to describe the measurement results.

The first experiment realises a three-path quantum Cheshire Cat where three properties, i.e. particle, spin, and energy of the neutron, seem to be spatially separated in three paths of the interferometer. For the experiment, different weak interactions are implemented one at a time in a path in the intermediate region between pre- and post-selection to locate the properties of the pre- and postselected quantum state. The interactions are absorption, a spin manipulation, and a coupled spin-energy manipulation. Each weak interaction causes a significant response only when applied in a different path. While the results allow for the interpretation of separated properties, the effect can be described without separation of properties.

In the second experiment, simultaneous path weak-measurements are performed. Through interaction with oscillating magnetic fields of different frequencies, the resulting weak energy manipulations uniquely mark each path with a time-dependent phase. The phase difference is observed at the output of the interferometer as a beating in the time-resolved intensity. Weak values are extracted from the fit parameters of a double-sine fit.

Both presented experiments involve which-way measurements. The retrieved weak values quantify the behaviour of the system with regards to different paths of the interferometer.