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One Step to Precision Measurement from Quantum Contextuality Test of Entangled Single Neutron[1] JIAZHOU SHEN, STEVE KUHN, ERIC DEES, SAMUEL MCKAY, SHUFAN LU, ABU ASHIK MD IRFAN, DAVID BAXTER, GERARDO ORTIZ, ROGER PYNN, MICHAEL SNOW, Indiana Univ - Bloomington — Quantum entanglement is a promising tool for improving measurement accuracy. Parity-odd neutron-matter interactions of the form $\vec{\sigma}\cdot\vec{p}$ can influence entangled neutron beams. We recently demonstrated neutron entanglement on the Larmor spectrometer at the ISIS facility through a series of quantum contextuality tests by breaking two types of inequalities. The Clauser-Horne-Shimony-Holt type inequality (for a neutron in Bell state of spin and position) and the Mermin type inequality (for Greenberger-Horne-Zeilinger state of spin, position and energy) were both violated with values beyond classical limit. These "entanglement witnesses" are constructed by inserting different phase shifts in individual qubit subspaces and performing spin projection measurements. The minimal decoherence experienced by the neutrons passing through a bulk quartz phase shifter promises to open new avenues for neutron metrology with possible future applications to the NSR and NOPTREX experiments. Additionally, neutron Wollaston prisms similar to the devices employed in this work can help to generate and characterize orbital angular momentum states of the neutron.

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