Parity-Odd Neutron Spin Rotation

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Nonleptonic weak interactions remain one of the most poorly understood sectors of the Standard Model [1]. The quark-quark weak interaction is known in the Standard Model and constitutes an internal probe of the strongly interacting ground state of QCD. Nonleptonic weak interaction amplitudes involving strange quarks in kaon and hyperon decay exhibit order-of-magnitude deviations from expectations based on flavor symmetries. Measurements of NN weak interactions can determine if the strange quark alone is to blame or if similar deviations exist for the other light quarks. Previous nuclear parity violation measurements provide a hint that the weak pion coupling may be suppressed relative to expectations. If measurements in few nucleon systems confirm that NN weak couplings are as crazy as kaon and hyperon weak decay amplitudes then we will have a new window on nontrivial light quark dynamics in QCD.

A recent effective field theory treatment of the weak NN interaction has appeared [2,3,4] which is consistent with the symmetries of QCD and describes low-energy weak NN processes in terms of 6 low energy constants, but only one of these constants is determined from past measurements of pp parity violation. Measurements of parity violation in low energy neutron reactions on H,D,3He, and 4He can be interpreted in terms of weak NN interactions[5,6].

A rotation of the plane of polarization of a transversely polarized neutron on transmission through unpolarized, homogeneous matter violates parity [7] and the phenomenon has been seen in heavy nuclei [8,9,10]. An experiment to search for PV spin rotation in n+4He was attempted in 1996 [11] and is now in progress at NIST [12] with a 3E-7 rad/m accuracy goal. A Letter of Intent to conduct a 1E-7 rad/m measurement in n-4He at SNS has been submitted [13]. PV spin rotation in n-p is technically feasible [14], and recent measurements of slow neutron depolarization at PSI [15] show that it is also possible to conduct a PV spin rotation measurement in solid orthodeuterium. Theoretical work to relate PV spin rotation observables to the coefficients in the new EFT weak NN treatment is in progress.

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