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First Observation of the Parity-Violating Asymmetry in Polarized Cold Neutron Capture on Hydrogen

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We report the first observation of the parity-violating 2.2 MeV gamma-ray asymmetry A_{γ}^{np} , in neutron-proton capture using polarized cold neutrons incident on a liquid parahydrogen target, at the Spallation Neutron Source at Oak Ridge National Laboratory. The asymmetry isolates the long-range component of the hadronic weak interaction, corresponding to the $\Delta I = 1, {}^3S_1 \rightarrow {}^3P_1$ component of the weak nucleon-nucleon interaction. Weak NN interaction observables in few nucleon systems are currently calculated, using modern effective field theory, the $1/N_c$ expansion formalism of QCD, and lattice gauge theory. We measured $A_{\gamma}^{np} = (-3.0 \pm 1.4 \text{ (stat.)} \pm 0.2 \text{ (sys.)}) \times 10^{-8}$, which implies a DDH weak πNN coupling of $h_{\pi}^1 = (3.1 \pm 1.5) \times 10^{-7}$ and a pion-less EFT constant of $C^{3S_1 \rightarrow 3P_1}/C_0 = (-5.2 \pm 2.4) \times 10^{-7} \text{ MeV}^{-1}$. We describe the experiment, data analysis, systematic uncertainties, and the implications of the result.

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