A MEASUREMENT OF PARITY-VIOLATING NEUTRON TRANSMISSION IN XENON

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We are preparing an experiment to measure the parity-violating asymmetry in polarized neutron transmission through xenon. There are two separate motivations for carrying out such a measurement. First, such a measurement would be a useful addition to the TRIPLE data set on the A-dependence of parity violation in compound nuclear resonances.[1] If enough measurements of parity-violating asymmetries are performed in many nuclei and in several resonances per nucleus, then statistical arguments can be used to gain information on the weak N-N interaction. In addition, a xenon target could be an attractive target in which to search for time-reversal-violating effects.

Polarized neutron transmission through polarized and aligned targets can be sensitive to T violation. For example, the forward coherent scattering amplitude for low energy neutrons can possess a term of the form $\mathrm{D}\vec{\mathrm{s}}\cdot(\vec{\mathrm{k}}\times\vec{\mathrm{I}})$ where $\vec{\mathrm{s}}$ is the neutron spin, $\vec{\mathrm{I}}$ is the target spin, and $\vec{\mathrm{k}}$ the neutron momentum. The motivation to attempt such a measurement has come from the discovery of very large amplifications of parity-violating effects in polarized-neutron transmission at energies near p-wave neutron resonances. The most spectacular example is the 0.734 eV p-wave resonance in ^{139}La, which possesses a parity-violating neutron transmission asymmetry at resonance of nearly 10%.[2]

The large parity-violation effects near p-wave resonances have been explained qualitatively as a dynamical enhancement by a factor $\langle\psi_s|V_p|\psi_p\rangle/\Delta E$ (Ref. 3), where ψ_s and ψ_p are s and p states of the compound nucleus and V_p is the neutron-nucleus parity-violating interaction. There is an additional resonance enhancement factor $\Delta E^2/\Gamma_p\Gamma_s$, where Γ_p and Γ_s are the total widths of the two states. It has been shown that a P and T violating interaction $V_{p,t}$ is enhanced near a p-wave resonance by the same factors as in the case of P violation.[4,5] For such a resonance, a search for $V_{p,t}$ at the $10^{-3}V_p$ to $10^{-4}V_p$ level becomes possible with current epithermal neutron beam intensities. Such an accuracy would rival the sensitivity to T violation achieved in searches for the electric dipole moment of the neutron.[6]

The ideal target for such a measurement would be a polarized solid whose polarization need not be maintained by a large external magnetic field. Recent studies have shown very long relaxation times in nuclear polarized solid xenon coupled with high production rates of polarized nuclei.[7] In addition, a polarized solid xenon target does not require a large external magnetic field to fix the polarization: such large fields can lead to false asymmetries in a polarized neutron transmission experiment. If xenon is shown to exhibit a large parity violating transmission asymmetry, then a search for time reversal violation will be seriously considered.

The Indiana group is responsible for constructing the xenon target. The target will consist of 1 kg of liquid xenon of natural isotopic abundance immersed in a magnetic field for maintaining the neutron polarization. Target design is finished, and tests of the target will begin in the summer of 1995. The experiment is projected to run at LANCSE in fall 1995.

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A STUDY OF SINGLE–PARTICLE PARITY–NONCONSERVING NUCLEAR MATRIX ELEMENTS

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There has been long-term interest in measuring the amplitudes for weak nucleon-nucleon interactions within nuclei. In particular, the dominant weak amplitudes are the isovector and isoscalar weak amplitudes, which correspond in a meson-exchange model to pion and rho exchange, respectively. The isovector amplitude is conventionally termed f_π and the isoscalar amplitude h_ρ^0. Limits on f_π and h_ρ^0 are found from decays of light nuclei, p-α scattering and, more recently, from low-energy neutron-nucleus scattering. Fig. 1 is a plot of present limits on f_π and h_ρ^0. A long-term goal of the measurements described here is to restrict the possible values of f_π and h_ρ^0 by putting limits on parity non-conserving