

Title: Laboratory Searches for Exotic Spin-Dependent Monopole-Dipole Interactions of Nucleons Using Polarized Noble Gas Ensembles

Abstract: Various theories for physics beyond the Standard Model predict the presence of new, weak forces of mesoscopic range (mm- μ m). One possibility is a new spin-dependent scalar-pseudoscalar interaction mediated by a spin-0 boson with a small mass [ref 1]. The resulting monopole-dipole potential is proportional to $\vec{s} \cdot \vec{r}$ where \vec{s} is the nuclear spin and \vec{r} is the separation between interacting particles. Using NMR measurements on ^{129}Xe , ^{131}Xe , and ^3He ensembles polarized by Spin Exchange Optical Pumping, we conducted two searches [ref 2, 3] for this interaction by moving a non-magnetic test mass near to the cell. Precise frequency measurements of the vapor cells set a new laboratory limit on monopole-dipole interactions between nucleons and unpolarized matter at distances near 1mm. This talk will also present the progress of the ARIADNE collaboration on a proposed experiment [ref 4] which will use Metastability Exchange Optical Pumping (MEOP) to polarize ^3He for a new monopole-dipole interaction search using resonant perturbation of the nuclear spin to amplify the NMR signal. The parameters of this experiment have been chosen to maximize sensitivity for the interaction range corresponding to the axion window.

refs: 1. Moody/Wilczek, PRD 1984 2. Bulatowicz et al, PRL 2013 3. P.-H. Chu et al, Phys. Rev. D 2013 4. Arvanitaki/Geraci, PRL 2014