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Laboratory Search for a Long-Range, scalar-pseudoscalar Interaction Using Dual-Species NMR with Polarized Xe129 and Xe131 Gas[1]
ERICK SMITH, Indiana University, Bloomington, M. BULATOWICZ, R. GRIFFITH, M. LARSEN, J. MIRIJANIAN, J. PAVELL, Northrop Grumman Corp., C.B. FU, W.M. SNOW, H. YAN, Indiana University, Bloomington, T.G. WALKER, University of Wisconsin, Madison — Various theories for physics beyond the Standard Model predict the presence of new weak forces of "mesoscopic" range (mm-μm). One possibility is a new spin-dependent scalar-pseudoscalar interaction mediated by a spin-0 boson with a small mass.[2] The strength of this interaction would be the product of the scalar (gs) coupling at the unpolarized vertex and the pseudoscalar (gp) coupling at the polarized vertex and is proportional to $\mathbf{s} \cdot \mathbf{r}$ where s is the spin of the source particle and r is the interaction distance. Using a test station for an NMR gyroscope at Northrop Grumman Corp., we conducted a search[3] for this interaction by measuring NMR frequency shifts in a vapor cell containing polarized ^{129}Xe and ^{131}Xe as a non-magnetic zirconia rod is moved near and far from the cell. The vapor cell features a long T2 spin relaxation time for both polarized species, allowing for very precise frequency measurements and a new laboratory limit to be set on this monopole-dipole interaction between the polarized neutrons in the nuclei and unpolarized matter at distances near 1mm.

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[2]Moody/Wilczek, PRD 30, 130 (1984)
[3]Bulatowicz et al., PRL 111, 102001 (2013)

Erick Smith
Indiana University, Bloomington

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