Abstract Submitted
for the APR18 Meeting of
The American Physical Society

An experimental search for exotic spin-dependent interactions with a spin-exchange relaxation-free magnetometer YOUNG JIN KIM, PING-HAN CHU, IGOR SAVUKOV, Los Alamos Natl Lab — Many theoretical extensions of the Standard Model of particle physics propose new fundamental bosons such as the axion and axionlike particles, which are prominent dark matter candidates. The exotic particles are very light and can mediate new macroscopic interactions between fermions with an interaction range from micrometers to centimeters. We propose a novel experimental approach to probe the exotic spin-dependent interactions using a spin-exchange relaxation-free (SERF) magnetometer, as both a source of polarized electrons and a detector. The SERF magnetometer is the most sensitive cryogen-free magnetic sensor reaching femtotesla sensitivity, and it contains a large number of alkali atoms in a vapor cell as the source of almost 100 % optically polarized electrons. This approach aims to detect magnetic-field like effects from the exotic interactions between the SERF polarized electrons and atoms of a solid-state mass. Based on our analysis and preliminary studies, we estimate that this novel method can improve the previous experimental limits from a few existing experiments and set new limits on most interactions in the interaction range below 1 cm.

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Date submitted: 27 Nov 2017 Electronic form version 1.4