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Probing sub-eV particles with 3He

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Many proposed extensions of the Standard Model of particle physics predict the existence of weakly interacting slim (sub-eV) particles (WISP). As WISPs are naturally Dark Matter candidate, they are actively search for using a great variety of experimental methods. Since WISPs are light particles, they could mediate a new interaction between ordinary particles with a macroscopic range. If the new interaction is spin-dependent, as in the case of Axion-like particles, it would generate pseudo-magnetic effects at short range. A new sensitive method has been recently developed in Grenoble to probe such a short-range pseudo-magnetic interaction, using hyperpolarized 3He gas. The pseudo-magnetic field possibly generated by the surface of a 3He cell would induce an anomalous depolarization of the 3He nuclei. The anomalous effect could be separated from the usual depolarization mechanisms by studying the longitudinal depolarization rate as a function of an applied magnetic field. The enhancement of sensitivity, as compared to other techniques, comes from the very long relaxation time (several days under certain conditions) of the polarized gaz.

A test experiment performed in 2010 at the Institut Laue Langevin (ILL) is already competitive in the search for exotic spin-dependent short-range interactions [A. K. Petukhov, G. Pignol, D. Jullien, K. H. Andersen, Phys. Rev. Lett 105 170401 (2010)]. A collaboration was then initiated between the LPSC and the ILL to set up a dedicated magnetic facility in order to improve the sensitivity of the method by a factor 50.

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