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Resonant Axion Searches with ^{3}He

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Axions are CP-odd scalar particles appearing in many extensions of the Standard Model. In particular, the Peccei-Quinn axion can explain the smallness of the neutron electric dipole moment and is also a promising Dark Matter candidate. Axions also generate macroscopic P-odd and T-odd spin-dependent interactions which can be sought in sensitive laboratory experiments. As the axion's coupling to ordinary matter is extraordinarily weak, most searches for its effect have looked very carefully for the direct evidence of cosmologicial axions. This talk will instead introduce a set of experiments that aim to measure fresh, locally sourced Axions by using a periodically modulated mass to drive precession in a hyperpolarized gas sample.

The Axion Resonant InterAction DetectioN Experiment (ARIADNE) is designed to search for axion-mediated spin-dependent interactions between nuclei at sub-millimeter ranges. The experiment involves a rotating tungsten mass to generate the axion field, and a dense ensemble of laser-polarized ^{3}He nuclei surrounded by a superconducting shield layer to detect the axion field by NMR. This novel technique will allow measurement of axions in the 100 μeV to 10 meV mass range, filling the remaining gaps in the traditional "axion window."

A preliminary version of the experiment with less sensitivity but zero cryogenics is being developed for the magnetically shielded room in Physikalisch–Technische Bundesanstalt (PTB) in Berlin. Like ARIADNE, this apparatus will use a mass rotating at the sample's Larmour frequency in an attempt to observe Axions via a resonant enhancement.

In this talk, I will first introduce the measurement technique before discussing the ongoing development of these experiments.

Summary

Some forms of Axions and Axion-like particles present as weak magnetic fields. We are developing experiments that use hyperpolarized helium-3 and NMR techniques to observe those effects.

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