Hyperpolarized ^{129}Xe for dark matter detection

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The Cosmic Axion Spin Precession Experiment (CASPEr) aims for the detection of possible candidates for dark matter, the axions. Axions are hypothetical particles that could also solve the strong CP problem, and it is predicted that the axion field would behave as a classical field: it would oscillate at a mass-dependent frequency [1].

They also have derivative interactions with the standard model fields. The project CASPEr-Wind, searches for spin precession induced by the coupling between the axion field and the axial nuclear current. The signal will be detected using nuclear magnetic resonance (NMR) techniques. Nevertheless, the signals from these particles will be very weak so all possibilities of enhancement need to be considered.

Here we present a method of signal enhancement using hyperpolarized ^{129}Xe. The hyperpolarization is achieved using spin-exchange optical pumping, in which the spin polarization is transferred to the xenon via Fermi Contact Interaction from an alkali metal, rubidium. We show the setup for production and polarization measurement of the xenon, and its optimization (Figure 1).

The hyperpolarized xenon is then to be placed in an external magnetic field that will be swept from ultralow field up to 14 T looking for the resonance with the axion-field.

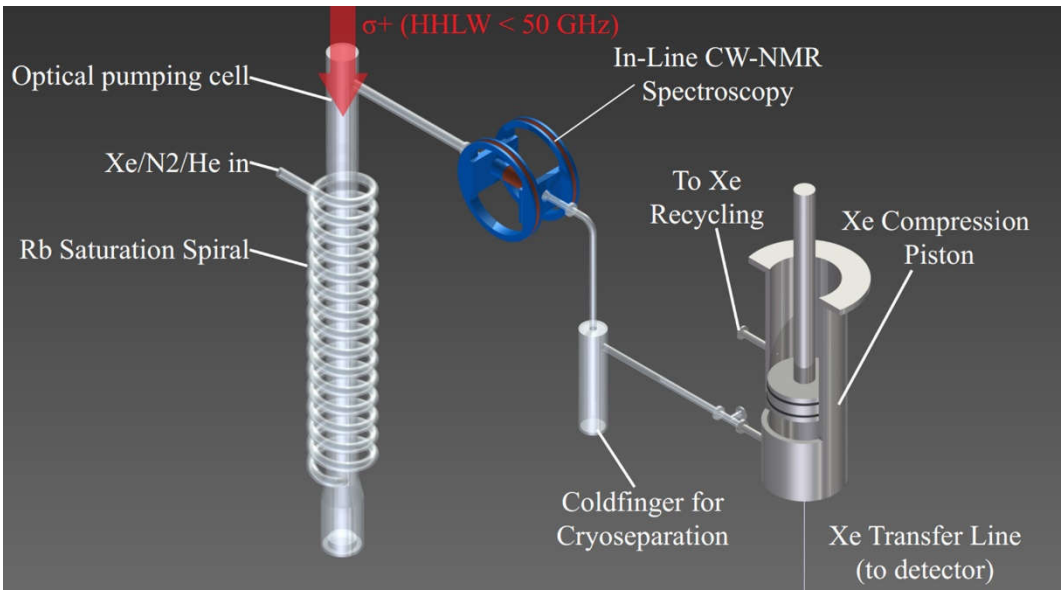

Figure 1. Hyperpolarized xenon setup for production and detection. Visuals designed by John Blanchard.

[1] D. Budker, P. W. Graham, M. Ledbetter, S. Rajendran and A. O. Sushkov; Cosmic Axion Spin Precession Experiment (CASPEr), 29 May 2014

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