

# Extra Physics with a Polarized Atomic Beam Source and a Lamb-Shift Polarimeter

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During times when the polarized internal gas target of the ANKE experiment, comprising a polarized atomic beam source (ABS) and a Lamb-shift polarimeter (LSP), is not mounted inside the cooler synchrotron COSY, it is used for other experiments. Below, we present a list of various projects, which we are going to pursue using the existing or equivalent hardware:

**1.) The PAX experiment:** It is well known that the polarization from a polarized target is transferred to a previously unpolarized proton beam in a storage ring (spin filtering). To optimize this method and to use it to polarize antiprotons is the aim of the PAX collaboration.

**2.) Precision spectroscopy:** With the spinfilter, which is the most important component of the LSP, it is possible to produce a beam of metastable hydrogen/deuterium atoms in one single hyperfine state. With induced single transitions between the different hyperfine states of the  $2S_{1/2}$  and the  $2P_{1/2}$  state, the hyperfine splitting energies, the Lamb shift and the Landè factors of the different hyperfine states can be measured very precisely.

**3.) Neutron decay / helicity of the neutrino:** In the neutron decay  $n \rightarrow p + e + \bar{\nu}_e$  it is possible that the final-state proton and electron are in a bound state as hydrogen atoms in different S states. The kinetic energy of 325.7 eV of this 2-body decay fits the energy range of the LSP. Therefore, the HFS population and the polarization of metastable hydrogen atoms after this decay can be measured, and, e.g., the neutrino helicity can be deduced from the results.

**4.) Polarized molecules:** When polarized hydrogen atoms recombine in a storage cell the nuclei of the residual  $H_2$  molecules may still be polarized. In this case the polarization of the protons/deuterons and the  $H_2^+ / D_2^+$  ions can be measured separately with the LSP.

**5.) Polarized fusion:** It is known for more than 40 years that the polarization of particles changes the total cross section of nuclear fusion reactions. For d+d reactions the situation is complicated and predictions are difficult. In an experiment, just started at PNPI, an ABS is used to produce the polarized jet target for such type of double polarized experiments, and a LSP is used to determine the polarization of beam and target.