Nuclear Hyper-polarization of ^{3}He in Magnetized Plasma for High-Field Magnetometry

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Abstract:

The nuclear spins of ^{3}He can be hyper-polarized at high magnetic fields (4.7 T) solely by a magnetized plasma [1], i.e. without any LASERs being involved. The conditions for such a magnetized plasma are fulfilled when the mean free collision path is much larger than the gyration radius of the free electrons in the gas discharge.

The induced atomic orientation results in absolute polarization levels of up to 10%. We explain this phenomenon by an alignment-to-orientation mechanism in the excited 2 ^{3}P-state of ^{3}He which is most efficient when the Zeeman and the spin-orbit energies are comparable.

Magnetometry at high magnetic fields [2,3] will obviously benefit from the PAMP-effect (**P**olarized **A**toms from **M**agnetized **P**lasma), because the experiment can be compacted or even miniaturized due to dispensable optical components. Here a relative precision of 10^{-12} is demonstrated. The limits of the methodology are discussed in view of relative [2] and absolute determinations of magnetic fields.

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