Applications of Noble Gas Magnetometry

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The spin-1/2 noble gases ^{3}He and ^{129}Xe provide nearly perfect two-state quantum systems for magnetometry. Spins are also sensitive to a number of non-magnetic couplings. For example, the electric dipole moment (EDM), a separation of charge along the atom's angular momentum vector is due to elementary particle forces that polarize the nucleus or atom that reveal something new about nature's and relate to the interactions that should have produced the baryon asymmetry in the early universe. Other couplings to spin, may include cosmic fields that violate local Lorentz Invariance by affecting nuclear energy levels that would be revealed in a system with spin greater than ½, for example ^{21}Ne (I=3/2). Because any system with angular moment has a magnetic moment, we developed the comagnetometer technique with ^{3}He to essentially measure the difference of exotic-physics effects between two species, while mitigating magnetic-field related systematic effects[1]. Over the course of several investigations[2,3,4] limitations of comagnetometry have been recognized. In parallel we have developed techniques of absolute magnetometry with ^{3}He, which requires corrections for a variety of systematic effects currently understood at the 10's of ppb level at ~1.45 T and relate to some comagnetometry limitations. In this talk, I will describe the fundamental motivations for EDM measurements and absolute magnetometry, and discuss technical details.

References

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