Optically-pumped magnetometry and comagnetometry with Bose-Einstein condensates

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Spin coherence is central to the performance of atomic sensors. In vapor-phase OPMs [1], and in solid-state spin-based sensors such as NV diamond [2], two-body interactions, e.g. collisions and dipole-dipole coupling, make the spin relaxation rate scale as the spin number density. This, along with spin projection noise, create a quantum limit for E_R, the energy resolution per unit bandwidth [3], a figure of merit for time- and space-resolved magnetometry. In contrast, a Bose-Einstein condensate (BEC) can have fully-coherent two-body interactions [4], and thus no limit on E_R. Recently, BEC sensors are starting to be used for imaging of magnetic structures in condensed matter systems [5,6], making plausible the idea that BEC sensors could have real applications. In this talk I will describe our own studies on optically-pumped magnetometers [7] and co-magnetometers [8] using Bose-condensed ^{87}Rb as an atomic medium. We break a long-standing record for E_R [7], and suggest a new application for these exotic sensors: the search for axion and axion-like dark matter [8].

References

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