# Spinor BEC comagnetometry for exotic physics searches

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Due to their exceptionally long coherence times and reduced dimensions, spinor Bose–Einstein condensates (SBECs) have proven to be ideal candidates for high-spatial-resolution optical magnetometry [1]. Axion-like particles are exotic ultra-light spin-0 bosons that would mediate a spin-dependent monopole-dipole potential between fermions [2], causing atomic spins to precess – analogously to their precession about a magnetic field. We propose using a $^{87}$Rb SBEC *comagnetometer* to search for exotic short-range spin-dependent interactions [3]. In the comagnetometer, each ground-state hyperfine manifold acts as a co-located magnetometer. Differential readout of the spin projection in both manifolds provides high-sensitivity detection of feeble exotic forces, while strongly suppressing the effect of the magnetic background. We discuss some of the technical challenges that appear when trying to adapt the current setup to one capable of setting new short-range laboratory limits on the monopole-dipole coupling strength.

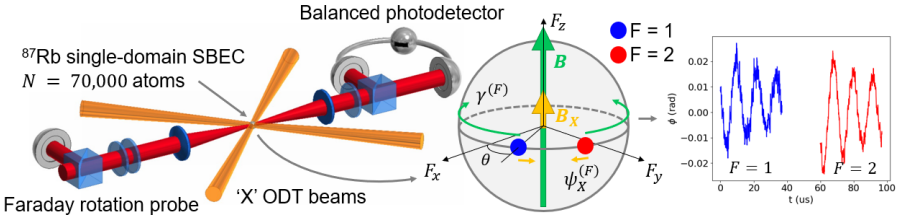


FIG. 1. SBEC comagnetometer readout protocol. Atomic spins precess about a magnetic field $B$ and an exotic *pseudo-magnetic field* $B_X$. We do the spin projection readout via *Faraday rotation probing* of both $F = 1$ and $F = 2$ manifolds.

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[3] P. Gomez *et al.*, *Phys. Rev. Lett.* **124** 170401 (2020).

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