Comagnetometry with synchronous spin-exchange optical pumping

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An important source of systematic error in comagnetometers based on spin-exchange optical pumping is longitudinal polarization of alkali atoms [1] and/or noble gas nuclei [2,3]. Such longitudinal polarization induces noble gas precession that does not scale with the gyromagnetic ratio alone. We suppress longitudinal polarization by optically pumping ^{85}Rb atoms transverse to a pulsed bias field [4]. The bias field pulses are low duty cycle and produce 2π precession of the Rb atoms. The noble gas nuclei ^{129}Xe and ^{131}Xe are simultaneously polarized via spin-exchange collisions with the Rb atoms. Their NMR is excited by modulation of the bias pulse repetition rate. We use the Rb to monitor each isotope's phase of precession and correct the bias pulse repetition rate modulation so that each isotope is continuously driven on resonance. We realize a factor of 300x suppression of common magnetic field noise by subtracting fluctuations common to the two isotopes. Configured as a gyro, the rotation sensitivity is less than 1 μHz after 200 sec of integration. Funding: The National Science Foundation and Northrop Grumman Corp.

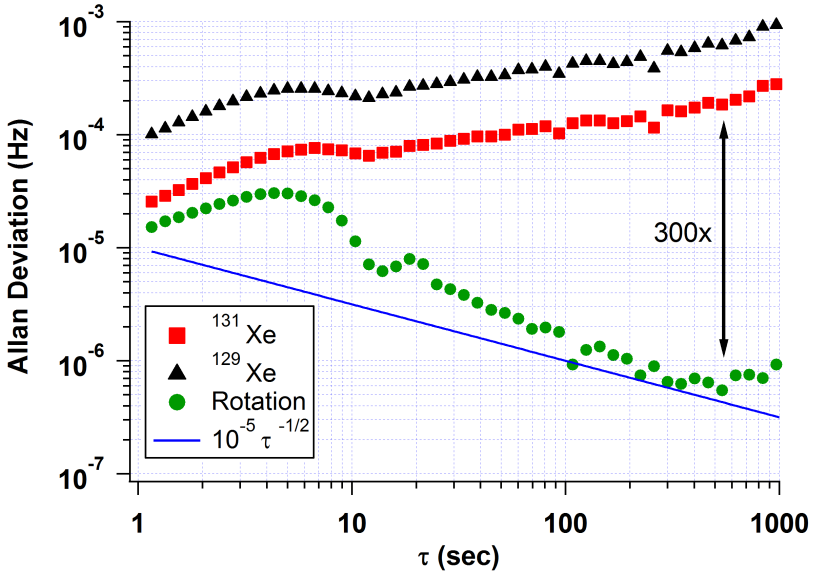

Figure 1. Allan Deviation of the precession of ^{131}Xe, ^{129}Xe and the computed rotation.

[1] T.G. Walker and M.S. Larsen, Adv. Atom. Mol. Opt. Phy. **65**, 373 (2016).
[2] M.E. Limes *et al.*, ArXiv e-prints 1805.11578 (2018).
[3] W.A. Terrano *et al.*, ArXiv e-print 1807.11119 (2018).
[4] A. Korver *et al.*, Phys. Rev. Lett. **115**, 253001 (2015).