Hot atom gyros

Thad G. Walker, Susan S. Sorensen, Zaynab S. Yardim

Dept. of Physics, University of Wisconsin-Madison, Madison, WI 53706 USA

NMR gyros [1] take advantage of the long coherence times of gas-phase noble gas nuclear spins to measure rotations (or other non-magnetic sources of frequency shift) while suppressing the ubiquitous fluctuations of magnetic fields. Using spin-exchange collisions with optically pumped alkali-metal atoms to polarize the nuclei and detect their Larmor precession, excellent signal-to-noise ratios are attainable, sufficient to promise navigation grade performance. The primary challenge is the control of systematic errors that arise from, for example, interactions with walls, hyperfine interactions with the spin-polarized alkali-metal atoms, and longitudinal spin-spin couplings between the nuclei themselves. Most of these errors arise from longitudinal spin polarizations. We have in recent years [2] developed a new approach to NMR gyros that produces predominantly transverse polarization of both the alkali-metal atoms and the nuclei, by synchronous spin-exchange optical pumping. Synchronization of the alkali-metal and nuclear spins is achieved by apply the bias magnetic fields in the form of alkali-metal 2π pulses, so that the alkali-metal atoms experience effectively zero field, while the nuclear spins precess about the time-averaged field. This talk will present our studies of the synchronously pumped NMR gyro. Research sponsored by U.S. National Science Foundation grant PHY-1912543 and Northrop Grumman Mission Systems' University Research Program.

[1] T. G. Walker and M. E. Larsen, Spin-exchange pumped NMR gyros, Advances in Atomic, Molecular, and Optical Physics **65**, 373 (2016).
[2] D. A. Thrasher, S. S. Sorensen *et al.*, Continuous comagnetometry using transversely polarized Xe isotopes, Phys. Rev. A **100**, 061403(R) (2019)