Rotation Sensing with a Trapped Barium Ion

RANDY PUTNAM, ADAM WEST, WES CAMPBELL, PAUL HAMILTON, California State University, Los Angeles — We present progress toward an experiment using a Zeeman qubit and a modified version of the recently developed spin-dependent kicks technique [1] to create an interferometric matter-wave gyroscope with a single $^{138}$Ba$^+$ ion in a linear Paul trap [2]. A rotation rate, $\Omega$ can be extracted by measuring the Sagnac phase: $\Phi = \frac{4\pi E}{\hbar c} (N \vec{A}) \cdot \vec{\Omega}$, where $E$ is the particle energy, and $N \vec{A}$ is the effective area of the interferometer. In order to reach sensitivities comparable to commercially available gyroscopes ($\sim 1\mu$rad s$^{-1}$Hz$^{-1/2}$) we take advantage of the increased energy afforded by using massive particles and allowing the ion to orbit in the trap $N$ times before closing the interferometer. With the ion’s long coherence time and a secular trap frequency of 10–100 kHz we hope to achieve $N = 100$ orbits in the trap. We have trapped and shown coherent control of a Zeeman qubit using a mode-locked Nd:YAG laser. This includes observing both Rabi oscillations and Ramsey fringes using a Raman transition between the qubit states.

Reference:


1Office of Naval Research, DARPA