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Large Momentum Transfer Point Source Atom Interferometer[1]

SELIM SHAHRIAR, JINYANG LI, WAYNE HUANG, GREGORIO RABELO, TIMOTHY KOVACHY, Northwestern University, MOHAMED FOUDA, Digital Optics Technologies — In a point source atom interferometer (PSAI), the magnitude of rotation can be inferred by carrying out a two dimensional Fourier Transform (FT) of the spatial distribution of atoms in one of the two quantum states. The locations of the peaks in the FT yields the magnitude and the direction of the rotation vector normal to the wavevectors of the light pulses. The sensitivity of such a rotation sensor, defined as the minimum measurable rate of rotation, is inversely proportional to the magnitude of the momentum imparted to the atoms. For a conventional PSAI, this momentum equals the sum of the momenta of the two photons exciting the Raman transition. This limit can be overcome by employing the technique of large momentum transfer using additional Raman pulses that couple two hyperfine ground states, for example. Ideally, if the amount of momentum imparted is N times that of a conventional PSAI, the sensitivity improves by a factor of N. However, because of increasing Raman detuning, the contrast in the fringes starts decreasing with increasing N. Beyond an optimal value of N, the sensitivity starts decreasing. The optimal value of N depends on the value of the effective Rabi frequency of the Raman transition. We will present results of a detailed numerical model, employing fully quantized wavepackets for the atoms, to illustrate this behavior. We will also present experimental results obtained for such a PSAI employing Rb-85 atoms.

[1]NASA

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