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Phononic crystal trapping geometries for improved rotational sensing with ultracold atoms

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Ultracold atom interferometry for inertial sensing in GPS/GNSS-denied environments presents a compact and more sensitive alternative to traditional methods such as light interferometry. While free-space interferometers have approached commercial scale implementation, trapping the atomic sample throughout the measurement may offer greater robustness to accelerations of the apparatus, although it is potentially limited by increased phase-diffusion due to two-body interactions at high densities.

Marti et al. [1] developed a sensor that measured rotation using the interference of counterpropagating standing-wave phonons in a ring geometry. Building on this work, we recently explored the sensing limits of this trapped atom system, experimentally finding an improved sensitivity of 0.3 rad s^{-1}. Numerical modelling found that higher harmonic generation by phonon mode mixing and thermal damping limit the lifetime of the imprinted phonons and the Q value [2].

To address this issue, we explore the implementation of a resonant phononic crystal geometry, extending our findings with atomtronic Helmholtz resonators [3]. We simulate the evolution of the system in this new geometry with the Gross-Pitaevski Equation, investigating the role of geometry on the lifetime of imprinted phonons and hence the theoretical Q value. Experimentally, confining the atoms to novel 2D geometries and limiting the thermal background may improve the sensitivity of the rotational sensor.

References

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Short bio (50 words) or link to website

https://www.uq-bec.org/lachlan-miller-1

Relevant publications (optional)

Career stage

Student

Author: MILLER, Lachlan

Co-authors: Dr WOFFINDEN, Charles; RUBINSZTEIN-DUNLOP, Halina; NEELY, Tyler (University of Queensland)

Presenter: MILLER, Lachlan

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