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Towards broadband quantum noise reduction in GWs using an atomic noise eater

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Broadband suppression of both shot noise and backaction noise in the GW interferometer can be achieved by adding an auxiliary table-top setup with a room temperature gas cell in magnetic field as the central element [1,2]. The basic idea is the measurement of motion beyond SQL using an atomic spin as a “negative mass oscillator”. The idea has been recently experimentally demonstrated for a nanomechanical oscillator by our group [3,4]. We are currently constructing a table-top setup aiming at the proof-of-principle demonstration of applicability of our approach to GWs.

1. Overcoming the standard quantum limit in gravitational wave detectors using spin systems with a negative effective mass. F. Ya. Khalili and E. S. Polzik, PRL 121, 031101 (2018).
2. Gravitational wave detection beyond the standard quantum limit using a negative-mass spin system and virtual rigidity. E. Zeuthen, E. S. Polzik, F. Ya. Khalili. PRD, 100, 062004 (2019).
3. Quantum back action evading measurement of motion in a negative mass reference frame. C. B. Møller et al. Nature, 547, 191 (2017).
4. Entanglement between Distant Macroscopic Mechanical and Spin Systems. R. A. Thomas et al. Nature Physics 17, 228–233(2021).

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