Dynamical response of Bose-Einstein condensates to oscillating gravitational fields

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Bose-Einstein condensates (BECs) are very small and extremely cold systems of a large number of atoms. These properties are famously exploited for high precision measurements of forces using atom interferometry. A further way of utilizing BECs as sensors for forces is to measure the forces' effect on the collective oscillations of atoms in BECs. A specific example is the measurement of the thermal Casimir-Polder force.

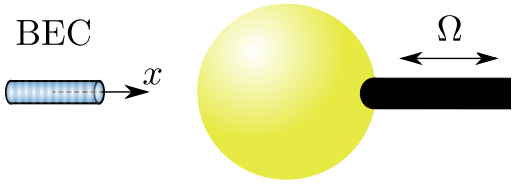

FIG. 1: The gravitational field of a gold sphere oscillating in front of a BEC creates phonons which, in principle, can be used for sensing the gravitational field.

In this contribution, it is explained how BECs can be used to measure oscillating gravitational fields [1]. Accelerations due to gravitational fields and their gradients give rise to effective external potentials, oscillations on resonance with elastic modes of BECs lead to the creation of phonons. For strong enough gravitational fields this effect can, in principle, be detected. For weaker gravitational fields, a squeezed probe state can be prepared and its change due to the interaction with the oscillating gravitational field may be measured. Our experimental proposal is illustrated with the easily accessible example of the gravitational field of a small oscillating gold sphere.

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[1] D. Rätzel, R. Howl, J. Lindkvist, and I. Fuentes, New J. Phys. **20**, 073044 (2018), arXiv:1804.11122 [quant-ph].

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