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Gravity sensing with Very Long Baseline Atom Interferometry

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Very Long Baseline Atom Interferometry (VLBAI) represents a new class of atom optics experiments with applications in high-accuracy absolute gravimetry, gravity-gradiometry, and for tests of fundamental physics. Extending the baseline of atomic gravimeters from tens of centimeters to several meters opens the route towards competition with superconducting gravimeters.

The VLBAI-test stand will consist of a 10m-baseline atom interferometer allowing for free fall times on the order of seconds, which will implemented in the Hannover Institut für Technologie (HITec) of the Leibniz Universität Hannover. In order to suppress environmental noise, the facility utilizes a state-of-the-art vibration isolation platform and a three-layer magnetic shield. We envisage a resolution of local gravitational acceleration of $5 \cdot 10^{-10}$ m/s^2 with an inaccuracy $< 10^{-9}$ m/s^2. Operation as a gravity-gradiometer will allow to resolve the first-order gravity gradient with a resolution of $5 \cdot 10^{-10}$ 1/s^2.

The operation of VLBAI as a differential dual-species gravimeter using ultracold mixtures of ytterbium and rubidium atoms enables quantum tests of the universality of free fall (UFF) at an unprecedented level [1], with the potential to surpass the accuracy of the best experiments to date [2]. We report on the first quantum test of the UFF using two different chemical elements, ^{39}K and ^{87}Rb [3], reaching a 100 ppb inaccuracy and show the potential of UFF tests in VLBAI at an inaccuracy of 10^{-13} and beyond.

References

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