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Towards Gravity Reference Stations with Very Long Baseline Atom Interferometry

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By relying on the well controlled and understood interaction of light with matter at the atomic scale, gravimeters based on matter-wave interferometry have shown remarkable stabilities. As absolute instruments, they now start to compete with classical sensors at the 10 nm/s^2 level. Furthermore, these devices exhibit a scale factor growing linearly with the free-fall distance of the atomic test masses. As a result, and complementing the efforts to bring this technology to the field as transportable devices, extending the free-fall distance from tens of centimeters to several meters puts instabilities below 1 nm/s^2 in 1 s in reach while keeping the absolute nature of the measurement procedure. This allows contemplating a new class of absolute gravimeters serving as reference for field instruments and base for the definition of height systems. However, besides the numerous challenges put on the atom-optical technology itself to operate such a large-scale atom-interferometer, assessing the performance of the instrument with statistical and systematic errors below 1 nm/s^2 is at least equally demanding.
In this contribution, we present our strategies to create and monitor a suitable environment for the Hannover Very Long Baseline Atom Interferometry (VLBAI) facility currently under construction in the newly founded Hannover Institute of Technology (HITec). We discuss in particular approaches to understanding and controlling magnetic and gravity field gradients along the free-fall trajectories through shielding as well as mapping and modeling. We also examine schemes to connect measurements from the VLBAI facility with those realized in the (classical) gravimetry lab installed in a nearby room of the same building, using as well auxiliary data such as that from nearby groundwater gauges. Building on established methods to compare absolute gravimetric measurements, this paves the way towards novel reference stations, taking into account the distinctive features of very long baseline atomic gravimeters.

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