

Mobile quantum gravity sensor with unprecedented stability

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The gravimetric atom interferometer GAIN is based on interfering ensembles of laser-cooled ^{87}Rb atoms in a fountain setup, using stimulated Raman transitions. GAIN's rugged design allows for transports to sites of geodetic and geophysical interest while maintaining a high accuracy compatible with the best classical instruments.

We compared our instrument's performance with falling corner-cube and superconducting gravimeters in two measurement campaigns at geodetic observatories in Wettzell, Germany and Onsala, Sweden. Our instrument's long-term stability of 0.5 nm/s^2 is the best value for absolute gravimeters reported to date [1]. Our measured gravity value agrees with other state-of-the-art gravimeters on the 10^{-9} level in g , demonstrating effective control over systematics including wavefront distortions of the Raman beams [2].

By using the juggling technique [3], we are able to perform gravity measurements on two atomic clouds simultaneously. Advantages include the suppression of common mode phase noise, enabling differential phase shift extraction without the need for vibration isolation. We will present the results of our first gravity gradient measurements.

[1] Freier, Hauth, Schkolnik, Leykauf, Schilling, Wziontek, Scherneck, Müller and Peters (2016). *Mobile quantum gravity sensor with unprecedented stability*. Journal of Physics: Conference Series, 8th Symposium on Frequency Standards and Metrology 2015, 723, 12050.

[2] Schkolnik, Leykauf, Hauth, Freier and Peters (2015). *The effect of wavefront aberrations in atom interferometry*. Applied Physics B, 120(2), 311 – 316.

[3] Legere and Gibble (1998). *Quantum Scattering in a Juggling Atomic Fountain*. Physical Review Letters, 81(1), 5780 – 5783.