Mitigation of vibrational noise in atom interferometry: hybrid sensing, large bandwidth sensors, and seismic attenuation

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Mitigation of seismic noise in atom interferometers is an inevitable task when aiming to operate sensors in field or dynamic environments or making use of large scale factors in very long baseline instruments on ground or in space. Here we report on the hybridization of an atom interferometer with a micromechanical resonator for high-bandwidth acceleration sensing to allow operation of the atom interferometer beyond its linear range in a noisy environment. Furthermore, in order to establish an unprecedented test stand for hybrid sensors as well as for highest-stability gravimetry measurements in the Very Long Baseline Atom Interferometer (VLBAI) we are implementing a state-of-the-art Seismic Attenuation System (SAS) based on technology developed in the realm of gravitational wave detection. We report on the design and first characterization results and estimate the SAS's potential in future stationary gravimetry measurements. The presented work is supported by CRC 1128 geo-Q, CRC 1227 DQ-mat, the German Space Agency (DLR) with funds provided by the Federal Ministry of Economic Affairs and Energy (BMWi) (Grant No. 50WM1641), and through the Quantum- and Nano-Metrology (QUANOMET) initiative.