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Atom chip gravimeter

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Atom interferometry has developed into a tool for measuring rotations [1], accelerations [2], and testing fundamental physics [3]. Gravimeters based on laser cooled atoms demonstrated residual uncertainties of few microgal [2,4] and were simplified for field applications [5].
Atomic gravimeters rely on the interference of matter waves which are coherently manipulated by laser light fields. The latter can be interpreted as rulers to which the position of the atoms is compared. At three points in time separated by a free evolution, the light fields are pulsed onto the atoms. First, a coherent superposition of two momentum states is produced, then the momentum is inverted, and finally the two trajectories are recombined. Depending on the acceleration the atoms experienced, the number of atoms detected in the output ports will change. Consequently, the acceleration can be determined from the output signal.
The laser cooled atoms with microkelvin temperatures used in state-of-the-art gravimeters impose limits on the accuracy [4]. Therefore, ultra-cold atoms generated by Bose-Einstein condensation and delta-kick collimation [6,7] are expected to be the key for further improvements. These sources suffered from a low flux implying an incompatible noise floor, but a competitive performance was demonstrated recently with atom chips [8].
In the compact and robust setup constructed for operation in the drop tower [6] we demonstrated all steps necessary for an atom chip gravimeter with Bose-Einstein condensates in a ground based operation. We will discuss the principle of operation, the current performance, and the perspectives to supersede the state of the art.

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