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ATOM INTERFEROMETRY ON SOUNDING ROCKETS

Abstract

One of the fundamental postulates of our description of nature is the universality of free fall, stating that the force exerted upon an object due to gravity is independent of its constitution. A precise test of this assumption is the comparison of the free fall of two ultra-cold clouds of different atomic species via atom interferometry. This novel technique represents a complementary test method compared to measurements based on classical masses and offers the possibility to test for previously inaccessible violation mechanisms.

The sensitivity of an atom interferometric measurement is proportional to the square of the propagation time of the atomic ensembles in the interferometer, i.e. the free fall time of the atoms. This time is in ground based experiments limited by the size of vacuum chambers used for preparing the atomic ensembles. The sensitivity can therefore be increased by performing the experiments in a microgravity environment. In order to fully utilize the potential of performing the experiments in microgravity the usage of a Bose-Einstein-Condensate as the initial state of the atom interferometer is necessary. This non-classical state of matter is characterized by a small initial size and a low expansion velocity.

As a step towards the transfer of such a system in space three sounding rocket missions with atom interferometers are currently being prepared. The launch of the first mission, aimed at the first demonstration of a Bose-Einstein-condensate in space and using this quantum degenerate matter as a source for atom interferometry is planned for 2016 from ESRANGE, Sweden. As a launch vehicle a VSB-30 rocket was chosen with a flight ticket provided by DLR MORABA. It will be followed by two more missions that extend the scientific goals to the creation of degenerate mixtures in space and simultaneous atom interferometry with two atomic species. Their success would mark a major advancement towards a precise measurement of the equivalence principle with a space-born atom interferometer. In this talk an outline of the missions is given, with a focus on the experimental realization of atom interferometers on sounding rockets.

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