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MICROGRAVITY SCIENCES AND PROCESSES (A2)
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PROSPECTS FOR APPLICATIONS OF COLD ATOMS IN MICROGRAVITY ENVIRONMENT

Abstract

Within the DLR funded project QUANTUS the technology for creating ultracold atoms and Bose-Einstein condensates in the microgravity environment of the drop tower in Bremen has been developed. This technology has been proven to be very robust and can be applied in future for practical purposes like inertial sensors for satellites. This new technology can also be used for new types of experiments in the area of fundamental physics which may be performed in free fall in the Bremen drop tower or on the ISS. These experiments very much benefit from a considerably enlarged experimental parameter space.

There are mainly two classes of experiments: (I) experiments testing the principles of quantum mechanics and (II) experiments exploring the coupling of quantum matter to gravity or, equivalently, exploring the structure of space and time by quantum devices. Experiments of the first class are (i) search for fundamental decoherence, (ii) measurement of the wave particle spreading, (iii) test of the superposition principle, (iv) test of the neutrality of atoms, (v) realization of quantum reflection and quantum diffraction which can be used for exploring the quantum object as well as the surfaces the quantum object scatters off. Experiments of the second class related to the gravitational interaction and the structure of space and time are (i) test of the equivalence principle (ia) in the gravitoelectric domain and (ib) in the gravitomagnetic domain, (ii) search for an anomalous dispersion relation, (iii) measurement of the energy levels of the (iiia) linear and (iiib) nonlinear Schrodinger equation in the gravitational field, (iv) realization of a gravitational quantum trampoline, (v) search for a hypothetical Finslerian space-time, (vi) realization of a giant gravitational hydrogen atom, (vii) testing the semiclassical Einstein equations, (viii) search for self-gravity effects.