Spectroscopy of Gravity

H. Abele

Atominstitut, Technische Universität Wien, Stadionallee 2, 1020 Vienna, Austria
E-mail: abele@ati.ac.at

Cosmological parameters describe the properties and the global dynamics of the universe. Observational cosmology has determined these parameters to one or two significant figure accuracy. Of great interest is now how the energy-matter budget is built up from its constituents: baryons, photons, neutrinos, dark matter and dark energy. The known particles of the Standard Model account for only 4%, whereas the majority consists of unknown dark energy and dark matter.

Both dark energy and dark matter might show up as tiny signals in gravity experiments and disclose their identity as e.g. a chameleon particle or an axion particle. They have triggered research of different kinds, which in the past ten years have validated Newton's gravitational law down to about 50 µm.

Missing so far were experiments with an absolute energy calibration based on natural constants and elementary particles. We present here a frequency ladder with a spacing based on the speed of light c, the Planck constant h, the mass of the neutron m_n, and the acceleration of the earth g in the quantized gravity potential of the earth, which is probed by a resonant spectroscopy technique.

In contrast to the frequency comb in laser spectroscopy, the frequencies in the gravity potential are not equidistant but given by the Airy-Functions, which allows us to use a resonant spectroscopy technique to probe the energies. A measurement of several discrete energy eigenstates of a neutron in the gravity potential of the earth in comparison with Newton's gravity law sets exclusion limits on the pseudoscalar axion-coupling in the previously unaccessible astrophysical axion-window or to scalar fields (chamelions).