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Diploma thesis

Development of a position-sensitive UCN detector with micron resolution

- Tests for deviations from Newton's Inverse Square Law at submillimitre distances and the question of extra dimensions of space time -

qBounce is a project of the Neutron & Quantum Physics Group at the Atomic Institute of the Austrian Universities. The aim is to realize gravitation experiments with ultracold neutrons. The experiments are planned here at the Atomic Institute and carried out at the European Neutron Source at the Institute Laue-Langevin in Grenoble/ France.

Motivation

The experiments are highly sensitive to Non-Newtonian gravity at a length scale below ten microns, where our previous experiments already place limits.
By realizing a quantum bouncing ball and resolving the time evolution of the system, we expect to constrain the existing limits further, because Newtonian gravity and hypothetical fifth forces evolve with different phase information. As such hypothetical fifth forces can be mediated from gauge bosons propagating in a higher dimensional space, the experiments can test speculations on large, submillimeter sized extra dimensions of space-time or the origin of the cosmological constant in the universe, where effects are predicted in the interesting range of this experiment and might give a signal in our setup.

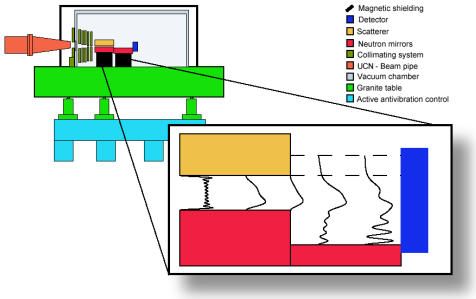

Fig.1: Quantum states in the earth's gravitational potential

Future planning

An important issue for the whole experiment is the detector because of the high spatial resolution that is required.
We use an organic substrate with very high purity, which is coated with a converter. Neutrons impinging on the converter, in our case ^{10}B, release nuclear fission reactions.
The fission products move back to back after the reaction. One of the particles now leaves a track in the organic substrate. Using an etching process, the radii of the tracks can be enlarged to the µm scale which is feasible for optical readout with a microsocope.
The diploma thesis contains taking the responsibility for the detector treatment for our new run of the experiment. This contains the further development of the coating and etching process, the calibration of the detectors and the optical read out.

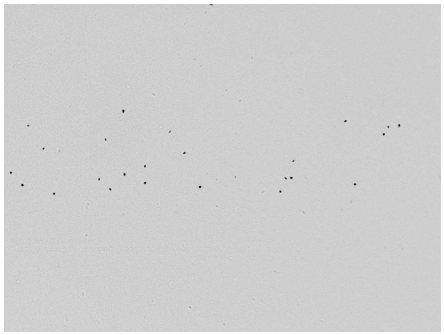

Fig. 2: Tracks of the fission products on our Boron-coated plastic detectors

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