

Probing the forces of gravity, blackbody radiation and dark energy with matter waves

Haslinger Philipp
TU Wien, Atominstitut

Atom interferometry has proven within the last decades its surprising versatility to sense with high precision tiniest forces. In this talk I will give an overview of our recent work using an optical cavity enhanced atom interferometer to sense with gravitational strength for fifth forces and for an on the first-place counterintuitive inertial property of blackbody radiation.

Blackbody (thermal) radiation is emitted by objects at finite temperature with an outward energy-momentum flow, which exerts an outward radiation pressure. At room temperature e. g. a cesium atom scatters on average less than one of these blackbody radiation photons every 10^8 years. Thus, it is generally assumed that any scattering force exerted on atoms by such radiation is negligible. However, particles also interact coherently with the thermal electromagnetic field and this leads to a surprisingly strong force acting in the opposite direction of the radiation pressure.

If dark energy, which drives the accelerated expansion of the universe, consists of a light scalar field it might be detectable as a “fifth force” between normal-matter objects. In order to be consistent with cosmological observations and laboratory experiments, some leading theories use a screening mechanism to suppress this interaction. However, atom-interferometry presents a tool to reduce this screening on so-called chameleon models. By sensing the gravitational acceleration of a 0.19 kg in vacuum source mass which is 10^{-8} times weaker than Earth’s gravity, we reach a natural bound for cosmological motivated scalar field theories and were able to place tight constraints.