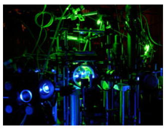

We are currently developing and studying new interferometric schemes based on ultra-cold strontium atoms. The aim of the project is high precision measurements of gravity acceleration for fundamental tests of General Relativity. In the past years our work has focused on cooling, trapping and manipulating ultra-cold ^{88}Sr, most abundant bosonic isotope of strontium. This isotope is well suited for precision measurements because of its particular properties. Amongst the known elements, ^{88}Sr possesses the unique characteristic of an almost vanishing scattering length. This means that a cold ensemble of ^{88}Sr can be considered as an ideal system of non-interacting particles. The most important consequence is the absence of decoherence among the external degrees of freedom due to the absence of cold collisions. Thanks to this property, long-lived Bloch oscillations in a vertical optical lattice could be observed up to 20 s with transfer of more than 1000 photon recoils. Furthermore, ^{88}Sr has a zero nuclear moment, and because of the presence of two valence electrons, the energetic ground state does not present any electronic moment. Therefore, ^{88}Sr has a zero total magnetic moment in its ground state, making the isotope insensitive to external magnetic fields. This is a precious characteristic for implementation in high precision measurements experiments, where the control of the spurious magnetic field is a real technical issue. Another interesting feature of strontium isotopes is the presence of narrow optical transitions. Such resonances can be used to produce ultra-cold thermal samples down to the recoil limit, and allow the implementation of fast optical cooling schemes toward quantum degeneracy. Ultra-narrow optical transitions also allow the development of the most stable and accurate optical clocks. We have acquired a wide knowledge in the coherent control of the quantum motion of atoms in optical lattices by means of resonant tunnelling techniques. This system demonstrated superior performances in precise measurements of forces at the um scale, and it is of great interest in short distance measurements. We have also used this system to perform differential gravity measurements between the ^{88}Sr and the ^{87}Sr isotopes to test Einstein Equivalence Principle (EEP). The employment of this combination of test probes is of special interest, as they not only have different masses but also possess a deeply different quantum structure. They undergo different statistics (one is a boson and one is fermion), and furthermore the bosonic isotope is completely spinless. With this system we were able to test the EEP at 10^{-7} level and put a constraint on the spin-gravity coupling violation. In order to drastically improve the performances of the gravimetric measurements, we are currently developing a new interferometric scheme based on Large-Momentum-transfer Bragg pulses and Bloch oscillations. With the powerful coherence properties of ^{88}Sr, the highest performances of this kind of interferometers are foreseen.

Useful resources

- More info about Strontium atom and his interest in ultra-cold atom physics