PhD position

Atom interferometry with ultracold helium

Research

The goal is to measure the fine structure constant α as accurately as possible using ultracold helium-4 atoms. In an atom interferometer experiment the recoil velocity that a helium atom gets after absorption of one 1083 nm photon will be measured. α can then be deduced from $\alpha^2 = 2R_\infty/c \times m_{He}/m_e \times h/m_{He}$ as the ratios $2R_\infty/c$ and m_{He}/m_e are known to much higher accuracy than the measured value for h/m_{He}. Confrontation with α calculated from electron g-factor measurements and QED theory will provide one of the most stringent tests of the Standard Model of physics.

Job description

In the project you work with advanced laser technology in an ultrahigh vacuum environment to manipulate helium atoms that have been cooled to a temperature of 0.2 μK and trapped in an optical dipole trap. The experimental setup is for a large part already available, see Appl. Phys. B **122**, 289 (2016), and uses a source of metastable helium (He*) atoms, collimated and slowed in a Zeeman slower by laser light. Atoms, trapped in a magneto-optical trap, are further cooled to Bose-Einstein condensation, transferred to an optical dipole trap and then launched for measurement of the recoil velocity using atom interferometry techniques in an optical lattice.

Light pulses will be applied to the ultracold atoms and the atomic wave packet, launched in the vertical direction with a momentum p_0, is split by Bragg scattering in two parts, moving with momentum p_0 and $p_0 + 2n\hbar k$ (n is the number of photon recoils $2\hbar k$ that is imparted to the atom). A second Bragg pulse creates two coherent wave packets which will be accelerated by *N* Bloch oscillations. A second pair of two Bragg pulses then recombines the wave packets closing the interferometer. The accelerated velocity is then very sensitively measured from the number of atoms in each output port of the atom interferometer, see Science **360**, 191 (2018) for a similar experiment using Cs atoms. The He* atoms are detected with high time resolution on a microchannel plate detector allowing well-separated output ports.

Location

The research is performed at LaserLaB Vrije Universiteit Amsterdam. The “Cold Atoms” team is part of the Physics of Light and Matter group that focuses on fundamental physics tests by precision measurements in small atomic and molecular systems. One PhD student already works on the experiment and a postdoc position is also available.

Job requirements

You have an MSc in (technical) physics or equivalent. You enjoy experimental physics and you are interested in precision measurements and tests of fundamental physics. Experience with experimental cold atoms research is a big advantage.

Conditions of employment

Start is November 1, 2018, or earlier. You become a junior scientist at NWO with a contract for four years. The salary is up to a maximum of 2,840 euro gross per month. Teaching (up to 10% of your time) at VU/UvA physics and astronomy is part of the appointment.

Contact & application

Dr. Wim Vassen, group leader ‘’Cold Atoms’’ group, Email: w.vassen@vu.nl, Phone: +31 (0)20 598 7949. For application please include a letter of motivation, your CV, and names with email addresses of one or two references.

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