IRTG-Seminar

IRTG CoCo

Dr. Wim Vassen

LaserLaB Vrije Universiteit Amsterdam

"Experiments with ultracold quantum degenerate metastable triplet helium atoms"

We apply laser cooling and trapping techniques to cool and trap helium atoms in the metastable triplet state. Temperatures below 1 microkelvin are reached where the atoms exhibit their wavelike character and Bose-Einstein condensation is observed for helium-4 and Fermi degeneracy for helium-3. I will first discuss our experiments observing bunching of helium-4 (boson) atoms and anti-bunching of helium-3 atoms (fermions). Then I will discuss our experiments exciting the 1557-nm transition between the metastable triplet state and the metastable singlet state (natural linewidth 8 Hz) in a 0.2 microkelvin cloud. We studied the line shape for both helium-4 and helium-3 observing a linewidth of 75 kHz for the fermions and a 15 kHz for the bosons at the same temperature, the latter only limited by the cold-collision mean-field of the Bose-Einstein condensate. Studying the helium-4 transition in a so-called magic wavelength optical dipole trap at 320 nm, we realized a 10 kHz linewidth and measured the transition frequency with 200 Hz accuracy, allowing stringent tests of quantum electrodynamics theory for two-electron atoms and quantum chemistry calculations of molecular potentials. The high accuracy provides a handle on the tiny shift of the transition frequency due to the size of the helium-4 nucleus (alpha-particle). These experiments are in the framework of the proton-size puzzle, where we hope to see whether the size of the nucleus in experiments in muonic systems differs from that of normal electronic matter.

Tuesday, June 12, 2018; 6:00 p.m., HSII
Physics high rise, Hermann-Herder-Str. 3

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