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Measurement of the occupation number of metastable atoms in the hyperfine-substate β_3 in an atomic hydrogen beam

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After the discovery of the Lamb shift in 1947 by Willis Eugene Lamb and Robert C. Retherford it was used to create Lamb shift polarimeter to separate the $2S_{1/2}$ α_1 and α_2 hyperfine substates of hydrogen as well as the α_3 substate of deuterium. But for a new project at the Technical University of Munich, the bound-beta decay of a neutron into a hydrogen atom and a neutrino, a Lamb shift polarimeter is needed that is also capable of separating the β_3 substate of hydrogen. Unfortunately, our first attempt to use a Sona transition unit to exchange the occupation numbers between α_1 and β_3 failed, because of the unexpected complexity of the transitions in this unit. The second idea of using a new kind of spinfilter which uses two radio frequencies to separate all four hyperfine substates of hydrogen also failed.
Our third attempt is now to build a transition unit that can induce magnetic dipole transitions between α_2 and β_3 as well as between α_1 and β_4 (π transitions). This transition unit should use a magnetic gradient field and a radio frequency to induce direct transitions between two hyperfine substates without oscillations with one of the $2P_{1/2}$ substates. This is a similar transition like use in atomic beam sources, in this case not for ground state but for metastable atoms, which leads to a much lower radio frequency. Another difference of this new idea is the smaller interaction time of the atoms with the photons inside the transition unit due to their much higher velocity of roughly 5·105 m/s compared to velocities of about 103 m/s after an atomic beam source.

Category

Polarimetry

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