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Studies of stimulated deexcitation for antihydrogen spectroscopy

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At the CERN Antiproton Decelerator (AD) facility antihydrogen atoms are routinely created by charge-exchange and three-body-reactions between antiprotons and positrons/positronium. The synthesized antihydrogen atoms allow precision tests of CPT symmetry and the study of the influence of gravity on neutral antimatter systems, possibly shedding light on the matter-antimatter asymmetry puzzle in the universe.
Upon formation the antihydrogen atoms predominantly occupy highly-excited Rydberg states which exhibit radiative lifetimes up to hundreds of milliseconds. However, spectroscopic experiments require antihydrogen atoms in their ground-state for probing the hyperfine splitting. While trapping experiments can wait for the spontaneous decay of antihydrogen into the ground state, in-flight experiments at the AD facility such as ASACUSA (Atomic Spectroscopy And Collisions Using Slow Antiprotons) require a technique for rapidly stimulating the repopulation into the ground-state, such that spectroscopic measurements can be performed in a field-free environment.
In this context, we introduce a novel technique for rapidly stimulating the decay into the ground-state via light-mixing of long-lived with short-lived states using THz and microwave emitters close to the formation region. This has shown to reduce the lifetime of the Rydberg states of interest by several orders of magnitude to some tens of microsecond. A proof-of-principle setup has been developed for investigating the stimulated deexcitation technique on a Rydberg hydrogen beam before being implemented on the synthesized antihydrogen atoms. The measured influence of these light sources on the atomic state distribution and the prospects of this technique in the context of precision measurements on antihydrogen as well as other potential applications are presented.

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