Stimulated decay and formation of antihydrogen atoms

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Antihydrogen atoms are prepared at CERN's Antiproton Decelerator (AD) complex via three-body-recombination processes (3BR) [1] and charge exchange (CE) reactions [2]. In order to perform precision spectroscopy and gravity measurements in a beam configuration, new ideas are needed to efficiently extract ground-state antihydrogen atoms from the formation traps into a field free environment. Although anti-atoms have been detected away from their formation region at rates consistent with solid-angle coverage [3], the range of Rydberg states populated through 3BR and CE mechanisms has not yet been Stark accelerated or magnetically focused into a ground state beam with sufficiently high rates for precision measurements. Novel techniques relying on light and crossed electric and magnetic field state mixing and deexcitation will be introduced [4,5]. Direct formation of ground-state atoms via stimulated radiative recombination combined with latter deexcitation techniques and data from a proof-of-principle experiment on a beam of Rydberg cesium [6] will be discussed. Finally, experimental efforts toward the formation of a Rydberg hydrogen beam (through laser excitation and collisional processes inside a microwave discharge plasma) to test deexcitation light sources will be presented.

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[3] Kolbinger, B. et al, Measurement of the Principal Quantum Number Distribution in a Beam of Antihydrogen Atoms, Eur. Phys. J. D 75:91 (2021).
[4] D. Comparat and C. Malbrunot. Stimulated decay and formation of antihydrogen atoms, Phys. Rev. A 99, 013418 (2019).
[5] T. Wolz, C. Malbrunot, M. Vieille-Grosjean, and D. Comparat. Stimulated decay and formation of antihydrogen atoms, Phys. Rev. A 101, 043412 (2020).
[6] M. Vieille-Grosjean, E. Dimova, Z. Mazzotta, D. Comparat, T. Wolz and C. Malbrunot. Induced THz transitions in Rydberg caesium atoms for application in antihydrogen experiments, Eur. Phys. J. D 75:27 (2021).