DAMOP05-2005-000101

Abstract for an Invited Paper
for the DAMOP05 Meeting of
the American Physical Society

Antihydrogen - Hydrogen Collisions

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Recently, both the ATRAP (G. Gabrielse et al., PRL 89 213404, (2002)) and ATHENA (M. Amoretti et al., Nature 419 (2002)) experiments at the CERN anti-proton decelerator have successfully created and detected low temperature antihydrogen atoms in the laboratory. Present efforts are directed toward the goal of trapping and cooling the antihydrogen into the ultra-cold regime in order to enable tests, of unprecedented accuracy, for some of the most fundamental symmetries of matter and anti-matter. Several methods for cooling have been proposed. Here we discuss the feasibility of cooling antihydrogen via its contact with ultra-cold matter, in particular hydrogen. The cooling efficiency is determined by the collision properties of this system. Annihilation of the leptons, the proton and antiproton, as well as re-arrangements into protonium and positronium during a collision conspire to limit the utility of sympathetic cooling. In this talk we will discuss the various collision processes and present calculated collision data in order to assess the viability of sympathetic cooling of antimatter in contact with matter. We will also discuss properties of the novel, unstable, exotic molecule (B. Zygelman et al., PRA 69, 042715 (2004)) that has been predicted as a possible by-product in a collision of antihydrogen with an hydrogen atom. Collaborators in this study include, A. Dalgarno, P. Froelich, S. Jonsell and A. Saenz. Partial support was provided by an NSF grant to the Harvard-MIT CUA where the author was a Visiting Scientist.