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Calculations of Hyperfine Antihydrogen Spectroscopy

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— In 2011, the Antihydrogen Laser PHysics Apparatus (ALPHA) Collaboration reported trapped antihydrogen atoms in the ground state,[1] placing spectroscopic measurements of antihydrogen within experimental reach. We present simulations for hyperfine spectroscopy of antihydrogen contained in a Penning-Malmberg trap. The trap used in the simulations approximates the magnetic fields present in the ALPHA trap. Using the Landau-Zener approximation we compute the transition rates for antihydrogen from a trapped, low-field-seeking state to an untrapped, high-field-seeking state when resonant microwaves are applied. We present results for each of the two low-field-seeking states. We show that resonances occur near the trap minimum, and that the rates are sufficiently high to distinguish spin-flipped antihydrogen atoms from cosmic noise counts. We determine that a pulsed application of the microwaves is optimal and show the feasibility of microwave spectroscopy, which can also serve as a detection tool for trapped antihydrogen atoms. We also report on the feasibility of laser cooling antihydrogen for future spectroscopic measurements.

[1]G.B. Andresen *et al*, Nature Physics **7**, 558 (2011).

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