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Magnetic Fields During Gravitational Experiments with Antihydrogen

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The Antihydrogen Laser Physics Apparatus (ALPHA) collaboration uses low energy antiprotons to produce, trap, and study the bound state of an antiproton and positron, antihydrogen. Hydrogen has been studied extensively through history and has many physical properties known to a high precision experimentally and theoretically. Therefore, comparisons between hydrogen and its antimatter equivalent offer highly sensitive tests of many fundamental symmetries. In a new venture, ALPHAg, the collaboration is attempting to observe the effect of Earth's gravity on antihydrogen through a controlled magnetic release.

ALPHAg will store low field seeking antihydrogen in a vertical magnetic minima trap, two short solenoids providing vertical confinement will then be slowly ramped down. Due to the difference in height between the two solenoids the trapping potential is different at each end by mgΔh, given this potential difference antihydrogen will "fall"in a direction biased by g and annihilate. Since this potential difference is equivalent to a ~ 4.5 Gauss magnetic field variation, and with a background field changing from 17000 Gauss to 10000 Gauss during release, it is clear this is only achievable through careful design, control, and measurement of magnetic fields.

I will introduce a technique developed in ALPHA that determines the in situ magnetic fields by measuring the cyclotron frequency of an electron plasma. I will then lay out the necessary steps to display control and understanding of the magnetic environment by showing results of extensive mapping of the on-axis field of several magnets, and characterisations of field drifts in the experiment. Finally, I will discuss the prospects and challenges related to making a measurement in a dynamic magnetic field in preparation for a gravity measurement.

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