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Description and first application of a new technique to measure the gravitational mass of antihydrogen

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ALPHA has searched for a propensity for antihydrogen atoms to fall downward when released from the ALPHA trap. We find that we can reject ratios of the gravitational to inertial mass of antihydrogen greater than approximately 100 at a statistical significance level of 5%. A similar search places somewhat tighter bounds on a negative gravitational mass, i.e., on antigravity. The technique utilizes the spatial and temporal resolution of our detector and the analysis involves detailed numerical simulations of antihydrogen dynamics in the trap. We have carefully studied both the systematics and statistics of this methodology. We find that with cooled antihydrogen atoms and detailed knowledge of the magnetic field profile, this technique has the potential to bound the gravitational to inertial mass ratio to values near unity.

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