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Matter-Antimatter Asymmetry in the Universe: Spectroscopy of Trapped Antihydrogen and Method for Direct Comparison with Hydrogen

We describe laser spectroscopy of the 1S-2S transition in trapped [1] and laser cooled [2] antihydrogen to 13 significant figures [3] and a lineshape theory [4] for its analysis. This is an order of magnitude improvement over our last results [5]. We discuss the extension of the methods to allow spectroscopy of hydrogen in the same apparatus as proposed in [6] and with a proof-of-principle with antihydrogen [7]. Addressing both atoms under the same conditions will minimize many systematic effects —such as the AC Stark shift and magnetic and electric fields besides sidereal localization —and will allow a direct comparison of the CPT conjugated species to 15 or more digits. The techniques have direct implications on tests of the Charge-Parity-Time (CPT) Symmetry, searching for explanations on the mystery of matter-antimatter asymmetry in the universe. The gravitational fall of antihydrogen [8], following an original proposal by the speaker [9] will be briefly discussed.

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