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Free Fall Experiments with Charged Particles - A historical journey

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The possible difference of gravitational interaction of matter and antimatter with the gravitational field of the Earth is an important open question in fundamental physics. Many indirect arguments against a possible difference have been put forward and have been summarized in a Physics Report by Goldman and Nieto in 1991. But no experimental answer to this question has been provided up to date.

An experiment to directly measure the difference in gravitational attraction by the Earth' gravitational field for electrons and positrons was launched in the 1960's by Witteborn and Fairbank. But due to the lack of low energy positrons at the time only the measurement with electrons was performed. This incomplete experiment raised many questions concerning stray electric fields in the apparatus and numerous studies were performed in subsequent years by the original authors and other groups around the world.

In 1985 we proposed an experiment based on the original ideas of Witteborn and Fairbank using antiprotons and protons. While this should be 1836 times easier than the measurement for electrons and protons it could not be completed in time before the shutdown of LEAR in 1996. Meanwhile several experiments at the AD have proposed studying gravitational properties of cold antihydrogen, which avoids issues of electric stray fields interacting with charged particles, but no results at any reasonable precision has yet been presented.

I will present details on the original experiment by Witteborn and Fairbank as well as the results of extensive studies by other groups on the observed apparent shielding of electrical stray fields at low temperatures.

Author: Prof. HOLZSCHEITER, Michael (University of New Mexico)

Presenter: Prof. HOLZSCHEITER, Michael (University of New Mexico)

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