ÉCOLE DE PHYSIQUE
des HOUCHES

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SCIENCES TECHNOLOGIE MEDECINE

Contribution ID: **2** Type: **not specified**

A new measurement of the electron mass

Being one of the elementary particles in the Standard Model of physics, the atomic mass of the electron is closely linked to other fundamental constants, such as Rydberg constants and fine structure constant. A high-precision value of the electron mass is fundamental for the structure of matter on atomic and molecular scales and is also an important ingredient of the most stringent tests of quantum electrodynamics [1,2,3].
Here an indirect method similar to [4,5] is applied to determine the atomic mass of the electron by measuring the spin-precession frequency of an electron bound to a carbon nucleus in a 3.76 T magnetic field. The single hydrogen-like carbon ion has been trapped for several months in a Penning trap apparatus with a cryogenic temperature of 4K working at an ultra-low pressure (p ≤ 10-16 mbar) vacuum chamber. The electron mass is then extracted from the g-factor of the bound state electron, where the ratio of the electron spin-precession frequency to the ion cyclotron frequency due to the magnetic field is required. The spin-precession frequency is determined based on the continuous Stern-Gerlach effect in a quantum non-demolition manner, while a phase-sensitive detection technique, PnA (Pulse and Amplify [6]), is crucial in determining the cyclotron frequency to an extremely high accuracy.

Summary

Combining this state-of-the-art QED calculation, which has been calculated to a precision better than 10−11, and our measurement of the ratio of the electron spin-precession frequency to the ion cyclotron frequency, we can derive the electron mass with a relative uncertainty of 3 • 10−11 [7]. We have improved the electron mass by a factor of 13 with respect to the previous CODATA value [8].

Reference

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