A 13-fold improved value for the electron mass

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The mass of the electron is a key parameter of the Standard Model of physics. Its value is fundamental for the structure of matter on atomic and molecular scales; a high-precision value is relevant for the most stringent tests of quantum electrodynamics [1,2,3].

Here we use an indirect method similar to [4,5] to determine the atomic mass of the electron by measuring the spin-precession frequency of an electron bound to a carbon nucleus in a 3.7 T magnetic field. The single hydrogen-like carbon ion has been trapped for several months in a Penning trap apparatus. While probing the spin-precession frequency, the magnetic field has been measured simultaneously with a novel phase-sensitive detection technique, PnA (Pulse and Amplify) [6], working at ultra-low temperatures. The spin-state is determined by applying the continuous Stern-Gerlach effect.

This approach requires the theoretical knowledge of the bound electron g-factor, which has been calculated to a precision better than 10^{-11}. Combining this state-of-the-art QED calculation and our measurement of the ratio of the electron spin-precession frequency to the ion cyclotron frequency, we can derive the electron mass [7]. With a relative uncertainty of $3 \cdot 10^{-11}$ we have improved the electron mass by a factor of 13 with respect to the present CODATA value [8].

In this talk the measurement of the electron mass will be presented and the current status of our BS-QED tests will be summarized.

References

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