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High-Precision Measurement of the Deuteron's Atomic Mass

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The rest masses of many light nuclei, e.g. the proton, deuteron, triton and helion are of great importance for metrology as well as in testing our current understanding of physics. For example the mass difference of triton and helion is used in an essential consistency check for the determination of the electron antineutrino rest mass in the KATRIN experiment [1],[2]. However, light ions are also especially challenging to measure because of sizable systematic frequency shifts originating in the relatively large ratio of kinetic energies compared to the low rest mass. Recently discussed discrepancies in light ion mass measurements, carried out at different mass spectrometers and sometimes termed "light ion mass puzzle"[3], give further motivation for independent measurements.
A new ion trap setup termed as LIONTRAP (Light ION TRAP), dedicated to high-precision mass measurements of light ions, has been constructed in an MPIK-GSI-University of Mainz collaboration.
We recently measured the proton's atomic mass by comparing the cyclotron frequencies of a single proton and a bare carbon nucleus [4], achieving a relative mass uncertainty of 3.2×10^{-11}, a factor of three more precise than the CODATA value [5], and revealing a 3σ deviation with respect to this value. This, however, is not enough to resolve the "light ion mass puzzle".
After a phase of upgrading the experiment we are currently measuring the deuteron's atomic mass in a similar manner compared to the proton mass campaign. The upgrades include a novel method of improving the magnetic field homogeneity as well as improved stability.
At this conference I want to discuss LIONTRAPs performance with the new upgrades. I will also present the systematic error budget of the deuteron measurement campaign, which is well below 1×10^{-11} relative, as well as preliminary results of the measurement.

References

[1] KATRIN Collaboration, KATRIN design report, Tech. Rep. (2005).
[2] E. Otten, Hyperfine Interact. 196, 3 (2010).
[3] S. Hamzeloui, J. A. Smith, D. J. Fink, and E. G. Myers, Phys. Rev. A 96, 060501 (2017).
[4] F. Heiße et al., Phys. Rev. Lett. 119, 033001 (2017).
[5] P. J. Mohr, D. B. Newell and B. N. Taylor, Rev. Mod. Phys. 88, 035009 (2016).

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