Measurement of the mass difference between tritium and helium-3

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The KATRIN tritium beta-decay neutrino mass experiment has reduced the limit on effective electron neutrino mass to 0.8 eV/c^2 (90% C.L), with an eventual aim of 0.2 eV/c^2 [1]. Using the novel method of cyclotron radiation emission spectroscopy, which inherently provides absolute electron energy calibration, the Project-8 collaboration aims to reach an eventual sensitivity of 0.04 eV/c^2 [2]. Comparing the value for the endpoint of the electron spectrum with the Q-value independently determined from the mass difference between tritium and helium-3 provides an important test of systematics in these experiments.

Here, improving on our previous measurement [3], we present results of a new precision Penning trap measurement of the mass difference between tritium and helium-3, obtained by measuring the cyclotron frequency ratios $HD^+/^3He^+$, HD^+/T^+ and $T^+/^3He^+$, each with an uncertainty of 10 parts-per-trillion or less. Our method uses pairs of ions simultaneously trapped in a Penning trap, alternated between large and small cyclotron orbits.

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[2] A. Ashtari Esfahini, et al, (Project-8 collaboration], arXiv:2212.05048v1 (2022).
[3] E. G. Myers, A. Wagner, H. Kracke and B.A. Wesson, Phys. Rev. Lett. **114**, 013003 (2015).