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Precision Atomic Mass for Neutrino Mass

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Observations of neutrino oscillations have shown that neutrinos can exist in three mass eigenstates and have produced values for the differences in the squares of their masses. However, the absolute masses are still unknown. One laboratory method for obtaining an upper limit to (and possibly measuring) electron-neutrino mass is to study the energy spectrum of the electrons emitted in a low-energy beta-decay near its endpoint. This approach is being pursued with the large-scale tritium-beta-decay experiment KATRIN, which should reduce the upper limit on electron-neutrino mass to below 0.2 eV. As an alternative approach, if it is assumed that neutrinos are Majorana particles, information on absolute neutrino mass can be obtained from the rate of neutrino-less double-beta decay, a process which has yet to be conclusively observed. In both approaches, an independent value for the beta-decay Q-value, as obtained from the mass difference between the parent and daughter atoms, is important in validating the neutrino mass limit obtained. After discussing this motivation, we will explain how we measure atomic masses to better than 0.1 parts-per-billion fractional precision using single ions in a Penning ion trap. We will also present our new result for the mass difference between tritium and helium-3, which has an estimated uncertainty below 0.1 eV.