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Uncovering the Proton Drip-Line of Tm with TITAN's MR-TOF Mass Spectrometer

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The change in nuclear binding energy associated with a nuclear decay or reaction can be determined directly using nuclear mass measurements. Precision mass spectrometry techniques, such as the Multiple-Reflection Time-of-Flight technique (MRTOF), are therefore indispensable tools for characterizing the strength of nuclear binding.

In the vicinity of the neutron-deficient limits of the N=82 shell closure, nuclear half-lives are sufficiently long to allow for high-precision mass measurements up to, and even across the proton drip-line. This provides a testbed for theoretical predictions of its location. Radioactive beam experiments were performed to establish the precise location of the proton drip-line in the Tm isotopic chain. This was achieved by obtaining previously unmeasured Tm masses, as well as by updating an anomalous mass contained within the 2020 Atomic Mass Evaluation.

These measurements utilized beams of radioactive isotopes produced at TRIUMF's Isotope Separator And Accelerator (ISAC), a well-established ISOL facility. ISAC delivered high-intensity beams to the MRTOF at TRIUMF's Ion Trap for Atomic and Nuclear Science (TITAN), where they were measured to precisions on the order of $\frac{\delta m}{m} \approx 10^{-7}$. Measurements of the rarest species were made possible by employing the recently implemented isobaric re trapping technique within the MRTOF to suppress contaminant species in the radioactive beam.

Primary author: KOOTTE, Brian (TRIUMF/University of Manitoba)

Co-authors: Mr DIETRICH, Kilian; Prof. DILLING, Jens (Oakridge National Lab); Ms DUNLING, Eleanor (TRIUMF); Prof. GWINNER, Gerald (University of Manitoba); Mr HOCKENBERY, Zachary; Dr IZZO, Chris (Fermi National Accelerator Laboratory); Mr JACOBS, Andrew (TRIUMF/University of British Columbia); Mr JAVAJI, Abhilash; Dr LAN, Yang; LEISTENSCHNEIDER, Erich (CERN); Ms LYKIARDOPOULOU, Eleni Marina (TRIUMF/University of British Columbia); Dr MUKUL, Ish; Dr MURBOECK, Tobias (University of Giessen); Mr PAUL, Stefan (TRIUMF/University of Heidelberg); REITER, Moritz Pascal (Justus-Liebig-Universität Gießen, II. Physikalisches Institut, Gießen, Germany, University of Edinburgh, EH8 9AB Edinburgh, United Kingdom); Mr RINGUETTE, Jon (TRIUMF); Dr SILWAL, Roshani (Applician State University); Mr SIMPSON, Rane; Mr WEIL, Ryohei; Dr KWIATKOWSKI, A.A. (TRIUMF/University of Victoria)

Presenter: KOOTTE, Brian (TRIUMF/University of Manitoba)

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