TRIUMF Advanced Rare Isotope Laboratory (ARIEL)

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Next-generation Penning-trap mass spectrometry at TITAN with ARIEL

Mass spectrometry plays an important role in many fields of physics research such as nuclear astrophysics, nuclear structure, and fundamental symmetries. Precise knowledge of masses is critical to these studies. For example, a relative mass precision of 10^{-8} is required to probe the Standard Model and beyond. This level of precision with radioactive species has been achieved only with Penning trap mass spectrometry. Coupling the Penning trap to an EBIT charge breeder allows for further improvement in precision by boosting the charge state of the ions. In order to extend storage time of these highly charged ions, the TITAN Penning trap system has been upgraded recently to cool the trap to cryogenic temperatures using cryoabsorption and cryocondensation, attaining a vacuum of 10^{-11} mbar. Currently, a phase-based technique to determine the frequency is being implemented which will allow the TITAN Penning trap mass spectrometer to achieve relative precisions $< 10^{-9}$. This new technique coupled with ARIEL's cleaner RIB production and longer beamtimes will allow for exciting science to occur. One such experiment is measuring the Q-value decay of Rb^{74} to Kr^{74}. Rb^{74} is a heavy superallowed emitter which will provide an experimental benchmark for isospin symmetry breaking calculations once the Q-value uncertainty is reduced. Using the decay and recapture ion trap technique in the EBIT, we can directly produce the daughter, Kr^{74}, more cleanly than via ISOL and the FEBIAD ion source. Thus, the TITAN Penning trap will make the highest-precision and -accuracy direct Q-value determination as well as individual mass measurements. We will present the status of the recent upgrades as well as the outlook for mass spectrometry at TITAN to test the Standard Model.

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