Contribution ID: **59** Type: **Talk**

Ion Trapping Developments at Edinburgh University, Towards Precise Mass Measurements of Light Exotic Nuclei at TITAN

Monday, 27 June 2022 15:35 (20 minutes)

High-precision mass measurements are essential for understanding the structure of exotic nuclei. These measurements serve as excellent tests of the latest nuclear models and provide key inputs for calculations in nuclear astrophysics. Light nuclei at the limits of nuclear binding are particularly important, as they are accessible with various ab-initio models, and so provide good tests for how these models perform in exotic conditions.

TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN) [1] at TRIUMF has specialised in the measurement of short-lived nuclei using a Penning trap and a multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) [2].

However, many light exotic nuclei are currently inaccessible at TITAN. Among these are several halo nuclei, as well as many nuclei which would provide important insight on the $N = 20$ island of inversion. Of particular interest is the halo nucleus ^{14}Be. The halo nuclei ^{11}Li, ^{6}He, and ^{8}He have all been measured at TITAN using the Penning trap [3, 4], but a precise measurement of ^{14}Be remains elusive due to its exceptionally low half-life and production rate. A first direct measurement of its mass would be an unprecedented test of current nuclear models. Mass measurements of neutron-rich isotopes of Na and Mg have also been elusive. Measurements of these masses would provide stringent tests of modern ab-initio theories, and help chart the precise extent of the $N = 20$ island of inversion.

The MR-TOF-MS excels at measuring scarcely produced nuclei with very low half-lives, and as such it increases TITAN's reach to include more exotic nuclei. This has allowed many new measurements, a recent example being the precision measurement of neutron-rich scandium near the $N = 32$ and $N = 34$ shell closures [5]. But to leverage this strength towards the study of light nuclei, a high frequency driver must be developed for the radio-frequency quadrupole (RFQ) system. This is required due to the frequency-dependent mass selectivity of RFQs.

We have developed a low cost alternative to commercial high frequency drivers for nuclear physics experiments. Five sin-wave drivers have been developed and are currently undergoing testing. Prior to the end of the year they should be installed at TITAN. They will be first employed in a measurement campaign of neutron-rich Na and Mg isotopes approaching the $N = 20$ island of inversion. An important feature of these drivers is a sense circuit, allowing for phase amplitudes to be matched directly.

This contribution will report ongoing ion trapping developments for TITAN at the University of Edinburgh, that will enable precise mass measurements of several light nuclei. Results from recent mass measurements will be presented, concerning halo nuclei, the $N = 20$ or $N = 40$ island of inversion.

[1] J. Dilling et al., Journal of Mass Spectrometry, 251(2), 198–203, (2006)
[2] T. Dickel et al., Hyperfine Interact 240, 62, (2019)
[3] M. Smith et al., Phys. Rev. Lett. 101, 2025201, (2008)
[4] M. Brodeur et al., Phys. Rev. Lett. 108, 052504, (2012)
[5] E. Leistenschneider et al., Phys. Rev. Lett. 126, 042501, (2021)

Primary author: BROWN, Callum (University of Edinburgh)

Co-authors: MOLLAEBRAHIMI, Ali (Justus Liebig University Gießen, TRIUMF); JACOBS, Andrew (TRIUMF, University of British Columbia); KWIATKOWSKI, Anna (TRIUMF, University of Victoria); WALLS, Coulter (TRIUMF); REITER, Moritz Pascal (University of Edinburgh); BLACK, Peter (University of Edinburgh); DICKEL, Timo (Justus Liebig University Gießen, GSI); MURBÖCK, Tobias (TRIUMF); PLASS, Wolfgang (Justus Liebig University Gießen, GSI)

Presenter: BROWN, Callum (University of Edinburgh)

Session Classification: Nuclear Physics

Track Classification: Nuclear Physics