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Nuclear Structure of Light Neutron-Rich Transition Metals via Mass Measurements at TITAN

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High precision mass measurement of exotic nuclei play an important role in shaping our understanding of the nucleus. It has become evident that the structure of the nucleus can change away from the valley of beta stability; new phenomena, as e.g. shell quenching, weakening or disappearance of classical and appearance of new magic numbers have been observed via characteristic signatures in the mass surface.

TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN) [1] located at the Isotope Separator and Accelerator (ISAC) facility, TRIUMF, Vancouver, Canada is a multiple ion trap system specialized in performing high-precision mass measurements and in-trap decay spectroscopy of short-lived radioactive species. Although ISAC can deliver high yields for some of the most exotic species, many measurements suffer from strong isobaric background. This limitation has been overcome by the installation of an isobar separator based on the Multiple-Reflection Time-Of-Flight Mass Spectrometry (MR-TOF-MS) technique [2]. In this device mass selection is achieved using dynamic re-trapping of the ions of interest after a time-of-flight analysis [3]. Re-using the injection trap of the device for the selective re-trapping, the TITAN MR-TOF-MS can operate as its own high resolution isobar separator prior to a mass measurements within the same device. This unique combination of operation modes boosts the dynamic range and background handling capabilities of the device, enabling high precision mass measurements of ions of interests with minuscule yields from strong background.

This contribution will discuss recent results of mass measurements of neutron-rich transition metals addressing the evolution of the exotic N=32 neutron shell closure and the N=40 island of inversion. Mass measurements of the most exotic light transition-metals, elements between Sc and Fe, were made possible due to new laser ion source development combined with the highly sensitive TITAN MR-TOF-MS. The new results shine light on the nuclear structure in this region of then nuclear chart.

References:
[1] J. Dilling et al., NIM B 204, 2003, 492–496
[2] C. Jesch et al., , Hyperfine Interact. 235 (1-3), 2015, 97–106
[3] T. Dickel et al. J. Am. Soc. Mass Spectrom. (2017) 28: 1079

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