MIRACLS: Laser spectroscopy in an MR-ToF device and the charge radii of exotic magnesium isotopes*

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A wide range of experimental techniques has been developed at radioactive ion beam (RIB) facilities to explore the limits of nuclear existence by studying exotic radioactive isotopes with extreme proton-to-neutron ratios. In this regard, collinear laser spectroscopy (CLS) has emerged as a powerful, nuclear model-independent tool to experimentally access nuclear ground-state properties of exotic isotopes such as spin, electromagnetic moments, and charge radii with high accuracy and precision.

In order to improve the sensitivity of conventional CLS, the Multi Ion Reflection Apparatus for Collinear Laser Spectroscopy (MIRACLS) exploits a new experimental approach by conducting CLS in a high-energy (> 10 keV) multi-reflection time-of-flight (MR-ToF) device [1, 2]. This is a type of ion trap which utilizes two electrostatic mirrors to reflect ion bunches back and forth for several thousands of revolutions. Hence, the ion bunches can be probed by the laser multiple times per measurement cycle to obtain higher statistics than with conventional CLS, which can study each ion bunch only once. In the most favourable spectroscopy schemes, offline measurements have demonstrated a sensitivity for yields as low as ~ 5 ions per second delivered to MIRACLS.

Building on these advances, a newly-built MIRACLS setup has been coupled to ISOLDE which has recently been exploited for the first time to determine nuclear charge radii of neutron-rich magnesium isotopes in the "island of inversion", extending previous measurements by COLLAPS [3].

In this contribution, I will describe the recent advances in the MIRACLS technique, present the results of the successful Mg online campaign, and discuss their physics implications. An outlook on the next physics goals at MIRACLS will be given, especially the laser-spectroscopy measurements of cadmium isotopes.

[1] S. Sels *et al.*, NIMA B. **463** (2020) 310-314.
[2] F. M. Maier *et al.*, NIMA A. **1048** (2023)
[3] D. T. Yordanov *et al.*, PRL **108:042504** (2012)

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