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# MIRACLS - A novel laser spectroscopy technique for observing the most exotic nuclei

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The assumption of universal magic numbers, i.e. closed nuclear shells, all across the nuclear chart has been a fundamental paradigm of the nuclear shell model. However, when exploring nuclides far away from stability, a disappearance of well-established shell closures can be encountered, which, for instance, manifests itself in the island of inversion around N = 20 [1].
Describing this shell evolution from first principles is a formidable task for nuclear theory. Recently, nuclear ab-initio methods have been able to expand their reach also into open shell nuclei. This advance now allows for ab-initio calculations of nuclear observables within the N = 20 island of inversion [2]. In order to deepen our understanding of this region of nuclides and challenge the predictive power of modern nuclear theory, experimental knowledge about the nuclear charge radii of neutron-rich magnesium (Z = 12) isotopes is crucial.
A powerful tool to access nuclear charge radii is collinear laser spectroscopy (CLS) [3]. However, to extend previous measurements [4] and explore the most exotic nuclides like $^{33,34}$Mg with very low production yields at radioactive ion beam facilities, more sensitive methods have to be envisioned.
The novel Multi-Ion-Reflection Apparaturs for Collinear Laser Spectroscopy (MIRACLS) at ISOLDE/CERN [5] combines the high spectral resolution of conventional fluorescence-based CLS with high experimental sensitivity. This is achieved by trapping ion bunches in a Multi-Reflection Time of Flight (MR-ToF) device, in which the ions bounce back and forth between two electrostatic mirrors. Hence, the laser-ion interaction time is increased with each revolution in the MR-ToF apparatus, while retaining the high resolution of CLS.
The new experimental setup consists of a buffer-gas filled Paul trap for providing cooled ion bunches, an offline ion source and an MR-ToF device, with built-in optical detection region and laser access.
Besides its use for CLS, MIRACLS'MR-ToF device will enable advanced MR-ToF mass separation with increased ion capacity [6]. At the next stage, this device will thus be able to deliver purified radioactive ion beams to PUMA and other (traveling) experiments at ISOLDE.
This oral contribution will introduce the MIRACLS concept, present results from a proof-of-principle experiment, show the new experimental setup as well as the first commissioning measurements and outline upcoming plans with the setup.

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