Contribution ID: **11** Type: **Poster**

MIRACLS: A novel approach for Collinear Laser Spectroscopy

Tuesday 3 December 2019 17:46 (2 minutes)

Due to its high accuracy and resolution, collinear laser spectroscopy (CLS) is a powerful tool to measure nuclear ground state properties such as nuclear spins, electromagnetic moments and mean-square charge radii of short-lived radionuclides. Performing CLS with fast beams (>30 keV) provides an excellent spectral resolution approaching the natural linewidth. However, its fluorescence-light detection limits its successful application to nuclides with yields of more than several 100 to 10,000 ions/s, depending on the specific case and spectroscopic transition.

To extend its reach to the most exotic nuclides with very low production yields far away from stability, more sensitive methods are needed. For this reason, the novel Multi Ion Reflection Apparatus for CLS (MIRACLS) is currently under development at ISOLDE/CERN. This setup aims to combine the high resolution of conventional fluorescence based CLS with a high experimental sensitivity, enhanced by a factor of 30 to 600. Within MIRACLS, this will be achieved by extending the effective observation time over a radionuclide's entire lifetime when the rare ions are stored in an Electrostatic Ion Beam Trap, also called Multi-Reflection Time-of-Flight (MR-ToF) device. A proof-of-principle apparatus, operating at ˜1.5 keV beam energy, has been assembled at ISOLDE/CERN with the goal of demonstrating the potential of the MIRACLS concept, to benchmark simulations that are employed to design a future device operating at 30 keV and to further develop the technique.

This talk will introduce the MIRACLS concept and present the first results with ions of stable magnesium and calcium isotopes which allow the systematic optimization of the MR-ToF operation for CLS. An outlook towards further developments will be given which includes the design of a "30 keV MR-ToF device", a necessity for the high resolution of CLS.

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Session Classification: Poster Session