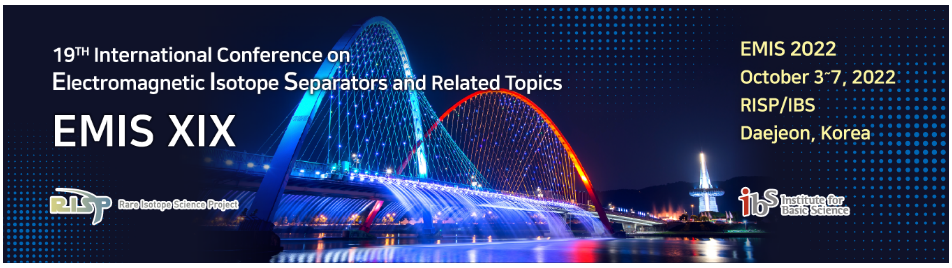

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Prospects for high resolution in-source spectroscopy using cross laser / atom beam geometry: Nuclear structure investigation on actinium isotopes with ISOLDE's new ion source PI-LIST

Monday, October 3, 2022 10:20 AM (20 minutes)

Laser resonance ionization spectroscopy in the ion source coupled directly to the isotope production target has been proven to be a highly sensitive tool for nuclear structure investigations on isotopes with low production and extraction yields [1]. While the efficiency of this technique is unrivalled, the spectral resolution is ultimately limited by Doppler broadening. At the ion source temperature of ~2000 ℃ typically required for efficient operation, Doppler broadening results in a 1-10 GHz experimental resolution limit whereas precise measurements of nuclear magnetic and quadrupole moments often require resolving hyperfine structure splittings below the GHz regime.

A new laser ion source design has been implemented at ISOLDE recently to provide in-source spectroscopy capabilities down to experimental linewidths of 100 –200 MHz, an order of magnitude below usual limitations. It is based on the high beam purity Laser Ion Source and Trap (LIST) [2, 3], featuring spatial separation of the hot cavity where potential ion beam contamination can arise from non-laser related ionization mechanisms such as surface ionization, and a clean laser-atom interaction region in an RFQ unit directly downstream where solely element-selective laser ionization takes place. In the so-called Perpendicularly Illuminated LIST (PI-LIST) [4], a crossed laser / atom beam geometry reduces the effective Doppler broadening by addressing only the transversal velocity components of the effusing atom ensemble.

Following the integration of this device as the standard tool for high resolution spectroscopy applications at the off-line mass separator facility at Mainz University [5, 6], we present its first on-line application at ISOLDE for nuclear structure investigations. Neutron-rich actinium isotopes in the region of assumed octupole deformation were probed, pinning down predictions of recent Energy Density Functional nuclear theories that incorporate reflection symmetry breaking [7].

Results of this experimental campaign, the applicability of the technique to ISOL facilities in general, its limits especially in terms of efficiency, and technical implementation challenges are discussed.

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