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Resonance Ionization Laser Spectroscopy with the Leuven gas cell-based Laser Ion Source

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After almost two decades of operation purified radioactive ion beams of more than 15 different elements, mainly devoted to decay studies, have been obtained by resonant laser ionization with the Leuven Isotope Separator Online (LISOL) facility, at the Cyclotron Research Center (CRC), Louvain-la-Neuve. Production and thermalization of radioactive species in a cell filled with ultra-pure buffer gas is used in combination with resonant laser radiation for selective ionization of the isotopes of interest in the Leuven gas cell-based laser ion source. These ions are extracted from the cell in a supersonic free jet and are transported by a radio frequency ion guide up to the mass separator, where they are segregated from non-isobaric contamination. Ion beams of high purity can then be sent to the detector station for the study of their characteristic decay radiation.

In addition to the routinely performed nuclear-decay-spectroscopy studies the recent implementation of a new concept gas cell [1] in the LISOL setup has allowed to perform in-source laser spectroscopy studies of neutron deficient 57-59Cu [2] and 97-102Ag [3] isotopes. These measurements have become feasible owing to the enhanced selectivity and sensitivity of the apparatus, which has allowed spectroscopic studies on exotic species with count rates as low as 6 ions/s for 57Cu (T1/2 =200 ms) or 1 ion/s for 97Ag, both semimagic nuclei. Online experiments are currently being carried out to pursue similar results on the actinium isotopes, where preliminary results were obtained for 212,213Ac.

In spite of the good results obtained by in-gas-cell laser spectroscopy the inherent pressure broadening makes this technique to be inapplicable to those elements with reduced hyperfine parameters and/or high sensitivity to atomic
collisions, as observed in practice, for instance, in the tin isotopes around A= 100. For the successful study of the atomic properties of these species in-gas-jet laser spectroscopy would be the technique of choice. In parallel to the online runs we are developing this technique, new for the study of rare isotopes, which will improve the resolution and efficiency of the present method. The proof of principle of in-gas-jet laser spectroscopy has previously been demonstrated at LISOL [4] and the full benefits of it recently evaluated with a high-repetition laser system [5].

Currently, we are constructing a laser laboratory at the K.U. Leuven to further develop and apply in-gas-jet laser spectroscopy for the study of heavy elements. Implementation of this technique will allow high sensitivity, high efficiency, and high resolution laser spectroscopy experiments on low-production-rate species using the Leuven gas cell-based laser ion source at S3 (GANIL) and GSI.
The necessary reduction of the existing laser linewidth (1.5 GHz) has been demonstrated lately by amplification of single mode cw diode laser light in a pulse dye amplifier resulting in a spectral resolution of 150 MHz in the reference
cell.

In my presentation I will report on the results obtained in the last online runs performed on the production of Ac beams and on the different tests carried out to accomplish in-gas-jet laser spectroscopy at LISOL in view of a full implementation of this technique in the future low energy branch facility S3, at SPIRAL2 or at GSI.

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[3] I. Darby et al. In preparation
[4] T. Sonoda et al., Nucl. Instr. and Meth. B 267 (2009) 2918
[5] R. Ferrer, V. T. Sonnenschein et al. In preparation

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