Contribution ID: **9** Type: **not specified**

Gas jet laser ionization: developments towards high selectivity for RIB production and high resolution studies of exotic atoms

Thursday 21 February 2013 10:40 (40 minutes)

Selective resonant laser ionization for the production of radioactive ion beams at gas cell-based facilities was pioneered by KU Leuven and more recently has been integrated at the IGISOL facility, Finland [1,2]. In an extension of this technique, a novel approach has been demonstrated in which neutral radioactive atoms are selectively ionized upon exit from the gas cell within the expanding gas jet [3,4]. This adaptation of the Laser Ion Source Trap method, proposed originally to improve the beam quality from a hot cavity ion source, aims for ultra-high purification of low-energy radioactive ion beams.

For ensuring the high efficiency of an on-line resonance ionization laser ion source, powerful pulsed lasers often operating in a high repetition mode (~kHz regime) with small duty cycle losses, are most suitable. These laser systems, whether dye or solid state, need to deliver sufficiently high power in order to saturate each individual excitation step. Standard broadband laser systems have spectral linewidths of a few GHz, which often masks sensitivity to hyperfine structure and isotope shifts, thus prohibiting a measurement of fundamental ground state nuclear structure (nuclear spins, moments and changes in mean-square charge radii).

Nevertheless, new opportunities have arisen and exciting results have been now been obtained via in-source spectroscopy on candidates with larger hyperfine parameters such as copper [5]. Currently, one of the most topical developments in the field is the application of resonance ionization in a gas jet. Both Doppler and pressure effects, which convolute and broaden the atomic linewidth, are substantially reduced thus making the environment attractive for a much wider range of short-lived nuclei. In this presentation I will summarize a variety of studies to improve the efficiency of the technique which thus far has been limited by the gas jet expansion [6]. The improvement in spectral resolution will be demonstrated by comparing with in-source spectroscopy.

The limitation to the resolution of in-jet laser ionization is the bandwidth of the pulsed laser systems. This presentation will also look at the novel developments which are currently being applied to solid state Ti:sapphire laser systems in order to specifically address this issue. Two approaches are being pursued: the first, an intermediate solution, utilizes synchronized control of a double-etalon laser cavity to achieve a linewidth <1 GHz. The second involves a more complicated technique of injection-locking the pulsed cavity to a cw master laser. This has been demonstrated to reduce the linewidth from a few GHz to tens of MHz [7]. I will show the latest results from JYFL, Mainz and RIKEN/Nagoya to illustrate the international efforts in this work.

[1] T. Kessler, I.D. Moore et al., NIMB 266 (2008) 681
[2] I.D. Moore, T. Kessler et al., NIMB 268 (2010) 657
[3] T. Sonoda et al., NIMB 267 (2009) 2918
[4] M. Reponen, I.D. Moore et al., Eur. Phys. J. A 48 (2012) 45
[5] T.E. Cocolios et al., Phys. Rev. Lett. 103 (2009) 102501
[6] M. Reponen, I.D. Moore et al., NIMA 635 (2011) 24
[7] T. Kessler et al., Laser Phys. 18 (2008) 842

Author: Dr MOORE, Iain (University of Jyväskylä)

Presenter: Dr MOORE, Iain (University of Jyväskylä)