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Highly-sensitive photodetachment spectroscopy in an MR-ToF device

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The electron affinity (EA) is the energy released when an electron is attached to a neutral atom. An experimental determination of this quantity serves as an important benchmark for atomic models describing electron correlation [1]. Several atomic spectroscopy studies aiming to answer questions in quantum chemistry, nuclear structure and fundamental symmetries rely on atomic theories of complex many-body systems. Unfortunately, the EA of several radioactive elements is still unknown and detailed information about isotope shifts or hyperfine splittings of EAs are only available for a handful of cases, all with modest precision.

A precise determination of EAs is possible via laser photodetachment threshold spectroscopy. The photon energy is scanned to find the minimal value necessary to detach the additional electron from a negatively charged ion. Since the photodetachment probabilities around this threshold are very low, this technique has so far been limited to mostly stable species which are available in large quantities. Up to now, pulsed high-power lasers are used to increase the photodetachment probability, which are, however, broadband and hence limit the measurement precision.
Employing the low-energy version of the Multi Ion Reflection Apparatus for Collinear Laser Spectroscopy (MIRACLS) at ISOLDE/CERN [4], we have performed a highly-sensitive photodetachment measurement on 35Cl. By trapping ion bunches between the two electrostatic mirrors of MIRACLS'multi-reflection time-of-flight (MR-ToF) device, the same ion bunch is repeatedly probed by the spectroscopy laser. As a result, the signal sensitivity is increased by 3 orders of magnitude while maintaining the high resolution of the collinear geometry. Additionally, we use a narrow-band continuous-wave laser.

Possible systematic effects of the new technique were carefully studied via dedicated measurements and ion-optical simulations. Finally, the EA of 35Cl was determined, which is in perfect agreement with the literature value [2,3]. Even though a factor ˜280,000 smaller ion sample was employed in our measurements compared to the previous single-passage measurement [3], we achieved a comparable precision thanks to the use of narrow-band continuous wave lasers and the repeated probing of the ion bunch in the MR-ToF device.

In addition to the present physics result itself, this advancement in photodetachment measurements at MIRACLS has opened a path for high-precision EA measurements with unprecedented sensitivity for various radioactive species.

I will present our measurement results on 35Cl and discuss the analysis methods, possible systematic effects as well as future application of the new technique for rare isotope sciences.

[1] D. Leimbach et al., Nat Commun 11, 3824 (2020).
[2] T. Carette and M.R. Godefroid, J. Phys. B 46, 9 (2013).
[3] U. Berzinsh et al., Phys. Rev. A 51, 231(1995).
[4] F. Maier et al., Hyperfine Interact. 240, 54 (2019)
S. Sels et al., Nucl. Instr. Meth. Phys. Res. B 463, 310 (2020).
V. Lagaki et al., Nucl. Instr. Meth. Phys. Res. A 1014, 165663 (2021).

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