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# Laser photodetachment spectroscopy in an MR-ToF device: towards the isotope shift measurements in short-lived radioinuclides

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The electron affinity (EA) is the energy released when an additional electron is bound to a neutral atom, thereby creating a negative ion. Due to the lack of a long-range Coulomb attraction, the EA is dominated by electron-correlation effects resulting in binding energies in the order of only a few electronvolts. Hence, negative ions represent intriguing probes for theoretical atomic models which consider physics beyond the independent particle approximation. A prime example for the importance of the accurate description of the electron correlation is the theoretical calculation of the specific mass shift. The latter is required when extracting nuclear charge radii from laser-spectroscopy work. Measurements of the EA hence represent an additional, new benchmark to validate and improve computational models.
Berzinsh et al. determined the isotope shift in the electron affinity of the two stable chlorine isotopes, 35Cl and 37Cl both experimentally and theoretically[1], but they only agreed to the order of magnitude. Later, Carette and Godefroid [2] improved the theoretical precision and received a value that agreed with the experiment, even improving the precision of the calculation beyond the accuracy of the measurement of Berzinsh et al.
Therefore, we have launched an experimental campaign to determine the isotope shifts in the EA between 35Cl and 37Cl isotopes with high precision. To this end, we have coupled a negative ion source to the multi-reflection time-of-flight (MR-ToF) device of the MIRACLS proof-of-principle setup [3,4,5], in which we aim to perform laser-photodetachment-threshold spectroscopy. By ”reusing”the negative ion beam during each revolution inside the MR-ToF device, the efficiency in the photodetachment and, thus, detection method is largely increased. This will allow us to employ continuous wave lasers, which leads to an improved precision in comparison to the previously used high power and broadband pulsed lasers. Moreover, we intend to measure the isotope shift of 36Cl (versus 35Cl) which will extend this type of studies for the first time to long-lived radionuclides.
Later on, this novel approach could be applied to EA isotope shift measurements of short-lived isotopes that require on-line production as well as EA determination of sparsely produced radioelements such as polonium and eventually superheavy elements.
Here, we will present the technique, developments, and the first results of the ongoing experimental campaign.

References:
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**Primary authors:** LEIMBACH, David (Johannes Gutenberg Universitaet Mainz (DE)); LAGAKI, Varvara (Ernst Moritz Arndt Universitaet (DE))

**Presenter:** LEIMBACH, David (Johannes Gutenberg Universitaet Mainz (DE))

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