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Precision Spectroscopy of Atomic and Molecular Negative Ions at the Frankfurt Low Energy Storage-Ring FLSR

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Negative ions are complex quantum systems in which an additional electron is bound to the neutral atom or molecule by a weak van der Waals force resulting from polarization of the electron shell. This binding depends strongly on the electron configuration of the shell and is therefore sensitive to electron correlation effects. Due to the lack of long ranged Coulomb force the resulting binding energies are small (typically around 1 eV) and exhibit rarely any excited states. Further there are almost no states with opposite parity and therefore lack of optically allowed transitions. The binding energy (electron affinity, EA) is typically the only accessible parameter in the spectroscopy of negative ions. The currently most precise measurement of the EA is by laser photodetachment threshold spectroscopy (LPT), where a narrow linewidth tunable laser is intersected with negative ions and the photon energy is scanned around the threshold, followed by detection of neutralized atoms.

Recently, the room-temperature electrostatic storage ring FLSR [1] at the University of Frankfurt was equipped with a source of negative ions and negative atomic and molecular ions have been successfully stored [2]. A high repetition-rate tunable Ti:sapphire laser pumped by a frequency doubled Nd:YAG laser developed at the University of Mainz has been installed and first photodetachment studies of O^- were performed. As a next step photodetachment studies of heavy atomic and molecular negative ions will be performed which will challenge state-of-the-art theoretical models. Results of the measurements will be presented and an outlook into future studies will be given.

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[1] K.E. Stiebing et al., Nucl. Instr. and Meth. A 614 (2010) 10-16
[2] O. Forstner et al., Hyp. Int. 241 (2020) 53

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