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A VMI setup to study prompt and delayed electron emission from trapped cluster anions

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Synopsis We have designed a velocity map imaging (VMI) setup and integrated it with an Electrostatic Ion Beam Trap (EIBT) to study photon induced prompt and delayed electron emission from trapped cluster anions. The operational details are discussed here. The performance of the VMI is also reported for photoionization of trapped O^- ions.

We report the performance of a velocity map imaging (VMI) setup which is designed to study photon induced prompt as well as delayed electron emission from trapped cluster anions in an event by event mode. The trapping of anionic species (produced in a cesium sputter source) is done with an Electrostatic Ion Beam Trap (EIBT) [1]. In the EIBT, 4.2 keV anions are kept oscillating along the trap axis in a field-free region between two electrostatic mirrors for a certain period of time (a few milliseconds to a few seconds). Our VMI setup is mounted perpendicular to ion beam direction in the field-free region of the EIBT.

Electron emission from the anions is induced by photons from a Nd-YAG laser with an OPO (Ekspla NT342 B-SH). The laser beam is introduced in an orthogonal direction to both the trapped ions and the VMI axis. The emitted electrons are extracted by electrostatic fields of the VMI and are detected by an MCP with a resistive anode encoder at its end. Electrons with different velocities will hit the detector at different radii, thus, the energy of the emitted electrons can be deduced. As the trapped anions are oscillating back and forth along the trap axis, the emitted electron experience an initial velocity along the motion of the anion which produces two shifted electron images. To overcome this, the ion beam is bunched within the trap by applying an RF potential to one of the trap mirror electrodes such that all the ions move in a particular direction during interaction with the laser beam. Electrons are now emitted from anions having the same initial velocity direction and thus we observe a single electron image on the detector albeit with a shift. Since the initial ion velocity is known, the energy of the emitted electrons can be reconstructed [2].

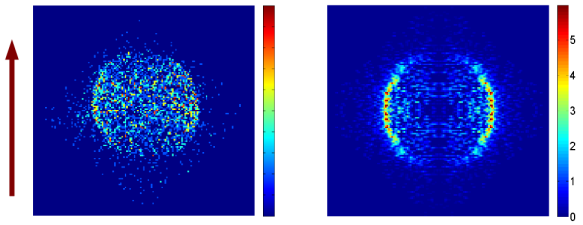

Figure 1. Photoelectron image upon ionization by 600 nm laser. Left: Raw image. Right: After inverse Abel transformation. The arrow shows the polarization direction of the laser.

We have tested the performance of our setup for trapped O^- beam. Various laser wavelengths (500 nm – 675 nm) were used to get photoelectrons of different energies for calibration purposes. The raw electron images were inverse Abel transformed using the BASEX code developed by Dribinski *et al.* [3]. Figure 1 shows the raw image and the inverse Abel transformed image of electrons emitted upon ionization by photons of 600 nm wavelength. The energy resolution was found to be 0.017 eV for 0.606 eV electrons emitted at 600 nm wavelength. We have also computed the asymmetry parameter from the angular distribution of the electrons. The value for asymmetry parameter at 600 nm wavelength was found to be $-0.84(10)$ which is in agreement with the value of -0.89 reported by Cavanagh *et al.* [4] for photoionization of O^- by photons of 532 nm wavelength. Experiments with hydrocarbons and cluster anions are in progress.

References

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