Core-Level Photoelectron Spectroscopy of Metal Clusters at FLASH

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Core-Level Photoelectron Spectroscopy of Metal Clusters at FLASH

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Synopsis Free size-selected metal clusters are investigated by core-level photoelectron spectroscopy at the free electron laser FLASH. The binding character of the clusters, as well as a multitude of relaxation channels are indicated by size-dependent core-level shifts and low-energy secondary electron emission, respectively. A new apparatus including a cryogenic ion-trap is currently built to extend the studies towards the smallest cluster sizes (less than 10 atoms), where low photo-absorption cross sections have to be matched by increased cluster density.

XUV radiation of high brilliance from the free electron laser facility FLASH (Hamburg) allows to access electronic core levels of free metallic clusters by photo-electron spectroscopy (PES). Recent experiments on lead cluster anions revealed a systematic shift of 5d and of 4f level energies as a function of cluster size [1,2]. For small clusters, a variation of the electron binding energy from the metallic sphere model is observed. It results from a reduced screening of the core-hole by the electrons, thus indicating a transition from a metallic to a non-metallic binding character in the cluster [2]. Moreover, a considerable contribution of low-energetic electrons in the PE-spectrum is due to electronic relaxation processes of the residual, highly excited cluster.

With increasing photon energies, but also with decreasing cluster size, the photoionization cross sections decrease rapidly, thus limiting the photo-electron yield. To increase the target density of size-selected clusters, and hence the electron yield, a new apparatus with a cryogenic, linear radiofrequency ion trap is currently being constructed (Fig.1). Additionally, such an ultra cold environment will prepare target clusters, which are close to their electronic and geometric ground states. With this setup many-electron dynamics due to x-ray photon absorption and highly-correlated phenomena on ultrashort timescales in clusters will be addressed in future experiments.

In this contribution, recent results on correlation effects in the photoemission of core-excited, mass selected metal clusters will be discussed, and the new ion trap setup will be introduced. The work is funded by the bmbf (FSP 302), and supported by the DFG (SFB 652).

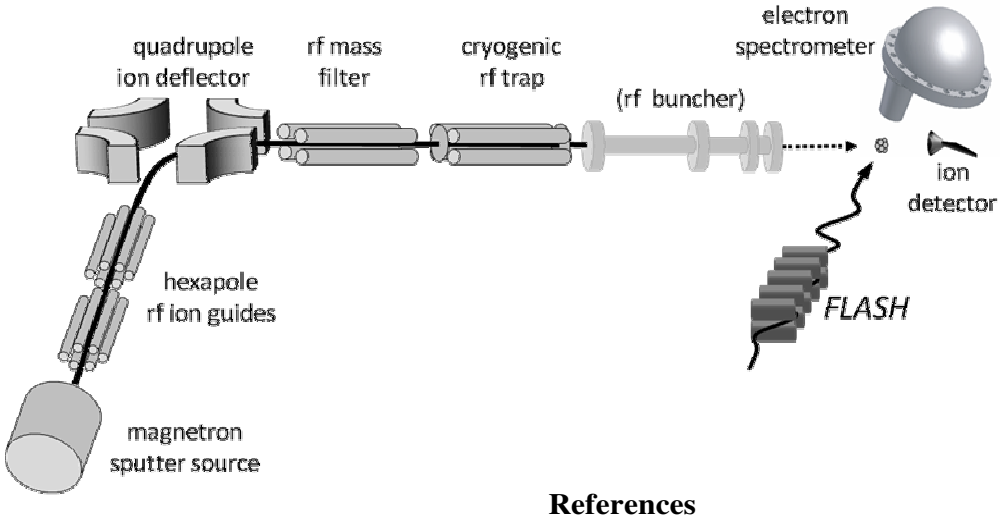

Figure 1. New experimental setup for core-level PES at free, small size-selected metal clusters.

References

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