Coulomb Explosion of Complex Systems: Metal clusters embedded in Helium Nanodroplets

Tilo Döppner, Thomas Fennel, Thomas Diederich, Paul Radcliffe, Josef Tiggesbäumker, and Karl–Heinz Meiwes–Broer

> Fakultät für Physik, Universität Rostock Universitätsplatz 3, 18051 Rostock

By the pick–up method up to 150 silver atoms are loaded into suprafluid helium droplets and form clusters. The ionic fragments of the interaction with intense femtosecond laser fields are detected with a high resolution time–of–flight mass spectrometer. We concentrate on intensities above 10^{13} W/cm² which lead to a complete disintegration of the clusters and the production of highly charged atomic fragments. In a single pulse experiment the most efficient charging is observed not with the shortest laser pulses (and hence the highest intensity) but with pulses having a width of several hundred femtoseconds. This time scale has been verified also in pump–probe experiments. The spectra show a sharp increase of the highly charged ion signal at optical delays of several hundred fs. Obviously a huge increase of the absorption cross section takes place which leads to the enhanced ionization efficiency. A similar behavior was observed for *free* metal clusters which was attributed to a coupling to collective excitations of the delocalized valence electron gas. In helium the ionization dynamics is more complex due to the droplet environment and a reduced time scale was found compared to the *naked* clusters.