Single-photon induced Collapse of Magnesium Complexes embedded in Helium Nanodroplets

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Synopsis In the present work recent results on photoelectron spectroscopy of Mg foam in He droplets probed by resonant two-photon ionization are presented. Spectra show complex structure, which can be attributed to a fast induced collapse of a metastable structure of Mg atoms inside the droplets.

There is evidence that magnesium atoms in helium nanodroplets form a metastable network of single atoms surrounded by a layer of helium atoms. At the conditions where only one Mg atom is presented in droplet, resonant two-photon ionization spectroscopy in the vicinity of $3^1P_1 \leftarrow 3^1S_0$ reveals a narrow peak blue-shifted relative to the atomic transition at 278 nm. With increasing of amount of Mg atoms, a second peak at 282 nm arise. This feature is present for doping levels in between 2-40 atoms and shows up irrespective of cluster size.The optical spectra suggest that single magnesium atoms are dissolved within the droplets having an interatomic Mg-Mg distance of about 10 Å, i.e. a magnesium foam is formed.

By scanning the laser wavelength close to the atomic and foam resonance photoemission probes the electronic structure of the Mg complexes after the excitation. Instead of a single photoemission line, complex photoelectron spectra are obtained when more than a single magnesium atom is present in the droplet but almost no specific pickup dependence is observed (Fig.1). New lines are refer to electrons emitted from excited states of Mg atoms, which could not be populated by absorbing of initial photon.

Similar spectra has been achieved at different droplet sizes from 10^3 up to 10^5 atoms per droplet. Analyzing the results with respect to the He pick-up statistics reveals the maximum foam size N_{crit}. We found that N_{crit} scales with droplet size, whereas all main features keeps unchanged.

The behavior of electron spectra can be attributed to highly excited atoms indicating a foam collapse accompanied by a rapid heating of the metastable structure.

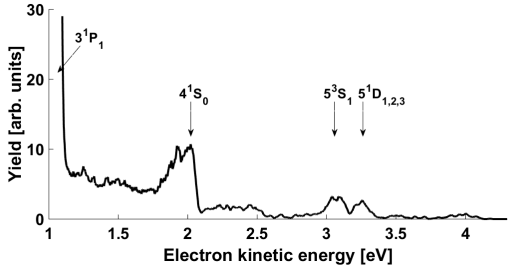

Figure 1. Photoelectron spectrum of Mg atoms embedded in He nanodroplets after resonant two-photon ionization at laser wavelngth 282,5 nm. Mean amount of Mg atoms $\overline{N}_{Mg}$=40.