New Frontiers in Atomic, Molecular, and Cluster Science with the New Seeded Free Electron Laser FERMI@ELETTRA

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The fourth-generation light source FERMI@Elettra is a seeded free-electron laser (FEL) which provides intense radiation in the extreme ultraviolet (XUV) for a wide range of applications in physics, chemistry and biology [1]. The combination of high-brilliance (>10^{13} W/cm^2), short-pulse (<100 fs), polarized, coherent light opens an opportunity to gain deeper insights into atoms, molecules and clusters. Here the first results on atoms and clusters under intense irradiation, obtained at the Low Density Matter (LDM) beamline of FERMI@Elettra are presented.

Two-photon ionization spectra of He atoms below and above threshold (24.587 eV) have been measured with linear and circularly polarized light. The resonant and non-resonant two-photon ionization processes in the XUV region (23.90-30.98 eV) covering the 1s–5p and continuum ionization of He^+ have been investigated. The relative values of the two-photon ionization differential cross-sections of these processes at different power densities of the FEL light were determined.

The photoelectron spectra of He-nanodroplets have been measured by velocity map imaging (VMI) [2] in the photon energy range 20–27 eV. They indicate that ionization occurs not only via a direct process at photon energies above the ionization potential (IP), but also at energies below the threshold. Electron spectra below IP strongly depend on total energy absorbed by a nanodroplet, and give evidence for a collective autoionization process with energy transfer between neighboring atoms within the same nanodroplet.

Measurements on doped He-nanodroplets subject to the FEL pulses have been performed as well. The transfer of excitation or ionization from the droplet to the dopant or vice versa has been studied, in particular as concerning the formation of nanoplasmas. For this purpose, a broad class of dopants, Ne, Xe, Li, SF_6, was investigated. The droplet size and doping level were systematically varied in order to elucidate the interplay between them.

References:
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