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SACLA: new opportunities for atomic, molecular, and cluster science with XFEL[1]

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Angstrom Compact free electron LAser (SACLA), started user operation in Japan [1,2]. We set up the program to investigate the dynamical behavior of heavy atoms as an isolated atom, in the molecule, and in the cluster, with SACLA. At 5.5 keV, with the fluence of 50 μJ/μm^2, we could identify that Xe^{n+} with n up to 26 is produced, evidencing the occurrence of deep inner-shell ionization and sequential electronic decay cycles repeated multiple times in the heavy atom within the XFEL pulse of $\sim$ 10 fs [3]. Reducing the photon energy to 5 keV, with the fluence of 50 μJ/μm^2, we could identify the occurrence of resonance-enabled x-ray multiple ionization [4]. The results for momentum-resolved multiple ion coincidence study on iodine-contained organic molecules illustrates that the charges are produced in the iodine site by the deep inner-shell ionization and sequential electronic decay cycles and spreads over the entire molecule within the FEL pulse duration (<10 fs), leading to Coulomb explosion. The light atoms, however, move significantly, a few hundreds pm for hydrogen atoms, before completing the ionization-decay cycles within the pulse duration of 10 fs. The results for electron spectroscopy on argon and xenon clusters illustrate that nanoplasma are formed by the XFEL pulse and continuous thermal emission from the plasma occurs in the time scale of ps.

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