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Ultrafast electronic and nuclear dynamics induced by intense, ultrashort XFEL pulses.[1]

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In 2012, SACLA, an XFEL in Japan, started user operation. We set up a program to investigate ultrafast electronic and nuclear dynamics in atoms, molecules and clusters induced by intense, ultrashort pulses generated by SACLA. At photon energy of 5.0-5.5 keV, we found an evidence for occurrence of deep inner-shell ionization and sequential electronic decay cycles repeated multiple times in the xenon atom within 10 fs pulse duration. The results for momentum-resolved multiple ion coincidence study on iodine-contained organic molecules illustrated that the charges are produced by the cycles of deep inner-shell ionization of the iodine atom and sequential electronic decay and spread over the entire molecule within 10 fs, leading to Coulomb explosion. The measured momentum distributions and correlations are well reproduced by MD simulations. The results for electron spectroscopy on rare gas clusters, with help of theoretical calculations, illustrated that a nanoplasma is formed by the XFEL pulse in tens of fs, and continuous thermal emission from the plasma occurs in ps. To probe these XFEL-induced ultrafast reactions in atoms, molecules, and clusters in real time, we carried out also XFEL pump-NIR probe experiments. The latest results will be shown and discussed.

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