Time-Resolved C_{60} Femtosecond Dynamics Induced by High Intensity X-rays from the LCLS

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Synopsis: Time-resolved experimental and theoretical photoionization of C_{60} using intense, short x-ray pulses from the linac coherent light source (LCLS) free-electron laser was studied. The aim of the work is to understand, in real time, the ionization and fragmentation dynamics induced by intense x-rays.

The real-time evolution of the photoionization and dissociation of large molecules at high x-ray intensity is unknown. Several models have been developed for studying the time evolution of the ionization of samples of increasing size irradiated by x-ray free-electron laser (FEL) pulses. We have validated in previous static work the successful use of classical mechanics to describe all moving particles in the photoionization of C_{60} [1, 2].

We show in Fig. 1, the real-space theoretical snapshots of the time evolution of a C_{60} molecule irradiated by an x-ray FEL pulse. The positions of the carbon atoms (red) and electrons (yellow) are shown as a function of time and spatial scale. The pulse duration used is 30 fs, with Gaussian pulse shape and a pulse energy of 345 mJ with photon energy at 485 eV.

We have carried out the time-resolved experimental and theoretical calculation of the photoionization of C_{60} using 640 eV photons with 20 fs pulse duration and with about 4×10^{15} W/cm^2 pulse intensity from the LCLS FEL at SLAC National Laboratory. The measurements were conducted using a magnetic bottle spectrometer to detect the electrons or fragment ions. The time-resolved data were generated using two x-ray pulses generated by the fresh-temporal slices using the LCLS accelerator scheme [3], to measure the ions and electrons resulting from the ionization as a function of delay time between the x-ray pump and the x-ray probe. We will present our results which will test molecular dynamics models and calculations [1, 2, 4].

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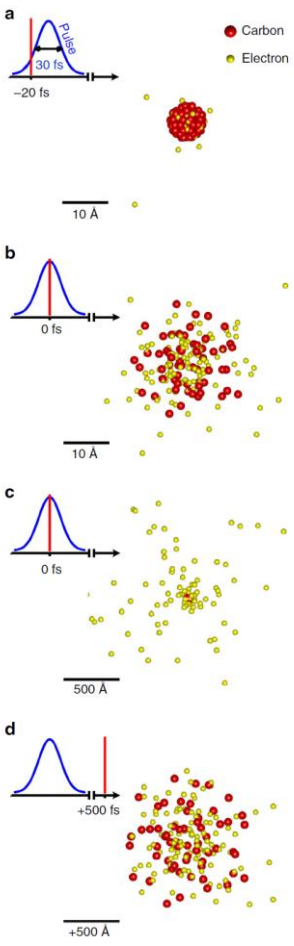

Figure 1. Real-space theoretical snapshots of the time evolution of a C_{60} molecule irradiated by an x-ray FEL pulse [1].

References

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