

MAR16-2015-000342

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Advancing the molecular movie: Femtosecond X-ray scattering of an electrocyclic chemical reaction¹

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Since it began operation in 2009, SLAC's Linac Coherent Light Source (LCLS) has allowed scientists to make new types of X-ray measurements that were once thought unattainable by delivering one trillion X-ray photons in incredibly short bursts of less than a few femtoseconds. It was promised that this astonishing quantity of photons, delivered in such a small slice of time, could capture the motions of atoms in chemical reactions. Now we have used this capability to make a "molecular movie" of a molecule undergoing a chemical reaction from start to finish, with frames just a few femtoseconds long. We assembled the movie by taking individual X-ray snapshots of the molecules that show the positions of their atoms at each moment in time. Comparing these results to computer simulations of the reaction, we determined the routes the individual molecules followed as it's structure rearranged. This is the first step in developing robust methods for visualizing molecular motions in chemistry, biology, and materials science at the atomic scale. Please enjoy the movie!

¹SLAC National Accelerator Laboratory U.S. DOE, Office of Science, Office of Basic Energy Sciences under Contract No. DE-AC02-76SF00515