Watching molecules split in real time

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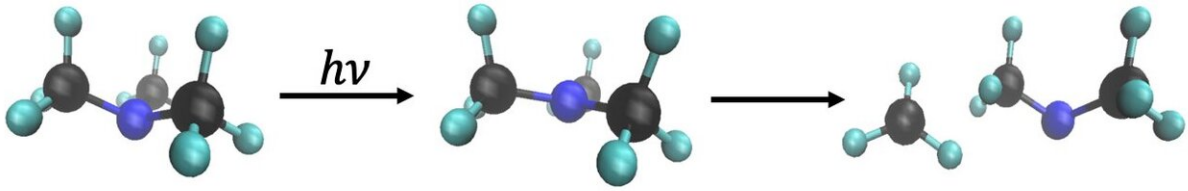

The researchers showed that when they excite the molecule with a photon, one of its methyl groups splits away. Credit: doi: 10.1002/anie.201902228

Using a new X-ray technique, a team of researchers was able to watch in real time as a molecule split apart into two new molecules. The method could be used to look at chemical reactions that other techniques can't catch, for instance in catalysis, photovoltaics, peptide and combustion research. The team, led by researchers from Brown University in collaboration with the Department of Energy's SLAC National Accelerator Laboratory, published their results in March in *Angewandte Chemie*.

The molecule, trimethylamine, comprises a nitrogen with 3 methyl groups on it. At SLAC's Linac Coherent Light Source (LCLS) X-ray laser, the researchers used X-ray scattering to measure changes in the structure of the molecule and how its electrons are arranged. They watched as one of the methyl groups split off when the molecule was

excited with light and found that while some of these methyls split off quickly, in about 640 millionths of a billionth of a second, others took their time, splitting off about 100 times slower.

What sets this study apart from others is that the researchers measured the process over a wide range of timescales. They also managed to reduce background noise, which, together with the brightness of LCLS, enabled them to catch signals they might otherwise have missed.

Jennifer Ruddock, a doctoral candidate at Brown University, was the study's lead author. SLAC's Mike Minitti and Brown's Peter Weber were the principal investigators. Researchers from the University of Edinburgh in the UK compared the data to theory. LCLS is a DOE Office of Science user facility. This work was largely funded by the DOE Office of Science.

More information: Jennifer M. Ruddock et al. Simplicity Beneath Complexity: Counting Molecular Electrons Reveals Transients and Kinetics of Photodissociation Reactions, *Angewandte Chemie International Edition* (2019). DOI: 10.1002/anie.201902228

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