PHYSICS UPDATE

Toward an attosecond view of molecules

Theory and experiment combine to examine an important ultrafast process in polyatomic molecules.

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The emerging field of attosecond science promises great things for molecular physics—including real-time observation and tomographic imaging of molecular electrons—but only if a hurdle between small molecules and larger molecules can be overcome. A key ingredient in every attosecond experimental technique so far has been ionization by a strong laser field. In the prevailing model of strong-field ionization, it's assumed that only one electron—the one with the highest energy—feels the pull of the ionizing laser field. Perhaps surprisingly, that simplification works well when applied to noble-gas atoms and some small molecules. But with larger molecules, it fails badly. Now, Albert Stolow (National Research Council Canada, or NRC) and colleagues have developed an experimental method for studying strong-field ionization in polyatomic molecules. When an electron other than the highest-energy one is removed from a molecule, the resulting ion often is unstable and breaks into smaller fragments, only one of which is charged. So by measuring both the departing electron's kinetic energy and the mass of the remaining ion, the experimenters can learn which electrons participate in the ionization. In the same paper, NRC theorists Michael Spanner and Serguei Patchkovskii present an ab initio method for solving the time-dependent Schrödinger equation for a molecule in a strong laser field. Applied to two different four-carbon hydrocarbon molecules, experiment and theory agree well, and both show that several electrons participate in the ionization. (A. E. Boguslavskiy et al., *Science* **335**, 1336, 2012.)—Johanna Miller