SPECTROSCOPY

ULTRAFAST PROBE

Attosecond laser method traces core-level electronic rearrangements

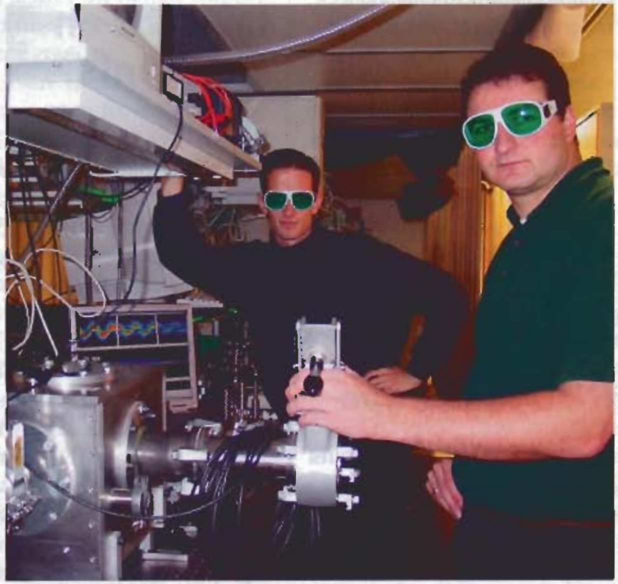
Using newly developed ultrafast laser methods, researchers in Austria and Germany have probed inner-shell electronic rearrangements in atoms in real time. The study may allow scientists to follow electron dynamics in chemical reactions with unprecedented time resolution.

Molecular vibrations and chemical reaction dynamics are commonly studied using femtosecond (10^{-15} second) pump-probe laser techniques. A short burst of visible or near-IR light pumps a specimen to an excited state; then, a precisely delayed follow-up pulse probes the evolution of the excited species. A series of molecular snapshots can be prepared by varying the delay between the pump and the probe pulses. But inner-shell electron shuffling takes place on an even faster timescale, so shorter bursts of light are needed to interrogate those processes.

Using attosecond (10^{-18} second) laser methods developed in their laboratory, Vienna University of Technology's Ferenc Krausz, Reinhard Kienberger, and Michael Hentschel; Markus Drescher, of the University of Bielefeld, in Germany; and coworkers determined that it takes just under 8 femtoseconds for electrons in krypton to reorganize themselves and "settle down" after a core-level electron is ejected from an atom [*Nature,* 419, 803 (2002)]. Until now, inner-shell excited-state lifetimes have been inferred indirectly.

By training soft X-ray pulses of attosecond duration onto a krypton target, the group dislodges an inner-shell electron from the atom, leaving behind a core-level vacancy. The excited electronic configuration relaxes via an Auger process involving two additional electrons—one of which (the Auger electron) is ejected from the atom—and probed with synchronized femtosecond visible laser pulses, thereby measuring the lifetime of the excited state.—MITCH JACOBY

DON'T BLINK
Using ultrafast laser methods, Hentschel (left), Kienberger, and their Vienna colleagues measure electronic shuffling with attosecond resolution.



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