Physicists observe electron ejected from atom for first time

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Physicists at the University of California, Berkeley in collaboration with researchers from the Max Planck Institute of Quantum Optics and the U.S. Department of Energy's Lawrence Berkeley National Laboratory, became the first researchers to observe the motion of an atom's valence or outermost electrons in real-time by investigating the ejection of an electron from an atom by an intense laser pulse.

In the experiments, an electron in a krypton atom is removed by a laser pulse that lasts less than four femtoseconds (one femtosecond is one millionth of one billionth of a second). This process leaves behind an atom with a pulsating positively charged hole in the valence shell, which originates from electronic wave functions of the atom.

The scientists led by Dr. Steve Leone, an ultrafast laser expert and the recent recipient of a National Security Science and Engineering Faculty Fellowship, used an extreme ultraviolet light pulse, the duration for which was 150 attoseconds (one attosecond is one billionth of one billionth of a second), to capture and photograph the movement of valence electrons for the first time.

This research into electron motions is expected to enable the scientists to better control processes and materials that will improve high-speed electronics and carbon-free energy sources that will benefit both the Air Force and consumers.

"If we want to understand high speed electronics, we need to work on changing molecular bonds in chemical reactions and the movement of electrons during chemical reactions or in complex solids which will only be possible by freezing time in a femtosecond," said Leone.

Dr. Michael R. Berman, program manager at AFOSR who is overseeing the scientists believes their research is an elegant example of the new capabilities of attosecond pulses to probe the dynamics of electron motions.

"This program and instrumentation will open new doors into probing fundamental physical processes on time scales faster than ever probed before."

Berman also noted, "These new tools will let us probe electron dynamics in materials and semiconductors and could help us understand and reduce electron loss processes to make electronics and devices like solar cells more efficient and to bring electronic data processing to its highest level."

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