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Attosecond pump-probe propsed to explore the dance of electrons

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Electrons in atoms move in a choreographed motion on a time scale of attoseconds (one quintillionth, or one billionth of a billionth of a second). To observe this ultrafast motion, physicists at Los Alamos National Laboratory have theoretically demonstrated an attosecond pump-probe technique that captures the steps in this intricate dance by ionizing the atom at selected times. The development of the proposed technique might someday allow scientists to actually see into a world of electron motion.

In research published recently in *Physical Review Letters*, Suxing Hu and Lab Fellow Lee Collins describe their work in modeling the dynamics of an attosecond probe, one of the first steps in building such a device. Based on existing femtosecond (quadrillionths of a second) devices that use ultrashort laser pulses to capture the motion of atoms in molecules, an attosecond pump-probe would use extreme ultraviolet pulses to capture the motion of electrons in atoms.

According to Hu, the principal investigator for the project, "the generation of extremely short EUV pulses has shown great progress in the last few years. The attosecond pump-probe technique described in our paper could provide a substantial advance in the rapidly developing field of "attosecond science" and could aid physicists, chemists and biologists in examining and manipulating ultrafast motions of electrons in atoms, molecules, clusters and even nanostructures."

Working much like a strobe light that helps capture stop-action photographs of a falling drop of water, a current generation of femtosecond probes use laser pulses to capture the fast motion of atoms during chemical reactions. Using attosecond pulses of extreme ultraviolet radiation, Hu and Collins believe it may be possible to capture the even faster motion of electrons within atoms and molecules.

The potential applications of the proposed technique not only include its use as a scientific tool that would enable scientists to understand ultrafast phenomena such as electronic transportation in nanomaterials and biological samples, but it also has potential applications for chemists that could allow them to better manipulate chemical reactions in order to design special molecules.

Source: Los Alamos National Laboratory, by Todd Hanson