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'Watching atoms move' is goal of powerful new X-ray sources, says CU's Joel Brock in Science article

By Anne Ju

When excited, atoms move at impossibly small length and time scales -- too small and too fast to have been observed in years past.

But as applied and engineering physics professor Joel D. Brock comments in the Feb. 2 issue of Science, a new generation of X-ray sources is allowing scientists to watch atoms move.

In his short paper, "Watching Atoms Move," Brock explains how scientists' understanding of matter is changing. The paper describes an international research collaboration based on a prototype X-ray machine at Stanford University.

Though not involved in the Stanford research, Brock is part of a Cornell team that is jockeying for leadership in this X-ray technology by building an Energy Recovery Linac (ERL). Still in design stages, the ERL would perform similar tasks but with more frequent X-ray pulses.

Brock's Science article concerns a group of 38 researchers led by D.M. Fritz of Stanford who, in the same issue, report on observations of oscillating atoms in an excited bismuth crystal, using a high-energy X-ray free-electron laser (XFEL). The XFEL prototype, called the Sub-Picosecond Photon Source (SPPS), was used to observe the atoms' motion and is the predecessor to a much larger machine, yet to be built at Stanford, the Linear Coherent Light Source (LCLS).

Cornell's ERL project is also in the beginning stages and would perform similar tasks, but with more frequent X-ray pulses. The university has garnered about $18 million in support from the National Science Foundation, as well as $12 million from New York state for preliminary work. The entire project, among the most ambitious undertaken at Cornell, would amount to a $300 million to $400 million investment.

The ability to observe and document the atomic activities, a domain of research known as sub-picosecond science, is now holding promise with the advent of linear accelerator based X-ray sources, which produce shorter-than-ever pulses, Brock explains.

He explains that while the XFEL at Stanford would pulse about 100 times per second, Cornell's ERL could pulse as fast as 1 billion times per second.

The machines are used for different kinds of experiments, but both belong to the new generation of X-rays sources for observing atomic activity.

"These new machines are magnificent," Brock said. "They're mind-boggling in what they'll be able to do."

Brock explained that the potential applications in other fields, such as chemistry or biology, are enormous. For example, traditional X-ray diffraction technology has long allowed scientists to observe viruses, but through snapshots only -- still pictures, limited by the speed of the X-rays.

Using the greatly improved X-ray sources, scientists could someday watch a virus move, see how it grabs on to a cell, and discover why it is harmful. That observation could lead to processes by which to disable the virus.

"We've seen the snapshot," Brock said. "Now let's see the movie."

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