

Study gives clues to increasing X-rays' power

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Three-dimensional, real-time X-ray images of patients could be closer to reality because of research recently completed by scientists at the University of Nebraska-Lincoln and a pair of Russian institutes.

In a paper to be published in an upcoming edition of *Physical Review Letters*, UNL Physics and Astronomy Professor Anthony Starace and his colleagues give scientists important clues into how to unleash coherent, high-powered X-rays.

"This could be a contributor to a number of innovations," Starace said.

Starace's work focuses on a process called high-harmonic generation, or HHG. X-ray radiation can be created by focusing an optical laser into [atoms](#) of gaseous elements - usually low-electron types such as hydrogen, helium, or neon. HHG is the process that creates the energetic X-rays when the laser light interacts with those atoms' electrons, causing the electrons to vibrate rapidly and emit X-rays.

But the problem with HHG has been around almost as long as the onset of the method in 1988: The X-ray light produced by the atoms is very weak. In an effort to make the X-rays more powerful, scientists have attempted using higher-powered lasers on the electrons, but success has been limited.

"Using longer wavelength lasers is another way to increase the energy output of the atoms," Starace said. "The problem is, the intensity of the radiation (the atoms) produce drops very quickly."

Instead of focusing on low-electron atoms like hydrogen and helium, Starace's group applied HHG theory to heavier (and more rare) gaseous atoms having many electrons - elements such as xenon, argon and krypton. They discovered that the process would unleash high-energy X-rays with relatively high intensity by using longer wavelength lasers (with wavelengths within certain atom-specific ranges) that happen to drive collective electron oscillations of the many-electron atoms.

"If you use these rare gases and shine a laser in on them, they'll emit X-Rays with an intensity that is much, much stronger (than with the simple atoms)," Starace said. "The atomic structure matters."

Starace said that unlocking the high-powered X-rays could lead one day, for example, to more powerful and precise X-ray machines. For instance, he said, heart doctors might conduct an exam by scanning a patient and creating a 3D hologram of his or her heart, beating in real time.

Nanoscientists, who study the control of matter on an atomic or molecular scale, also may benefit from this finding, Starace said. Someday, the high-intensity [X-rays](#) may be used to make 3D images of the microscopic structures with which nanoscientists work.

"With nanotechnology, miniaturization is the order of the day," he said. "But nanoscientists obviously could make use of a method to make the structures they're building and working with more easily visible."

Source: University of Nebraska-Lincoln ([news](#) : [web](#))

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