New Path Toward X-Ray Lasers Found

Researchers have long sought an efficient means of generating intense bursts of short-wavelength X-rays to create a laser. Such a source could be used to image matter, allowing the study of living biological tissue and other materials on an atomic or molecular scale.

This possibility now appears closer with the discovery of a new method for producing X-rays in clusters of atoms. Charles K. Rhodes and his coworkers at the University of Illinois at Chicago have shown that clusters of xenon atoms irradiated by extremely short, powerful pulses of ultraviolet light can generate X-rays having wavelengths ranging from 2 to 3 angstroms.

"The work demonstrates an important new mechanism for the production of a highly desired form of excited matter," Rhodes says.

The team's measurements also provide crucial information indicating how the process can be greatly improved. "These findings give promise for the construction of the brightest light sources ever produced at any wavelength," Rhodes says.

The researchers report their results in the Aug. 25 NATURE.

Groups throughout the world have expended a great deal of effort trying to develop an X-ray laser. However, the success of these efforts has generally been limited to "soft" X-rays, having wavelengths of 100 angstroms or more. In one scheme, researchers at the Lawrence Livermore National Laboratory in Livermore, Calif., have obtained X-ray wavelengths as short as 45 angstroms.

To achieve even shorter wavelengths, the trick is to find a way of concentrating power so that a source, such as an ultraviolet laser, can effectively deliver energy in an extremely brief burst to a restricted volume of the X-ray-generating medium.

Taking a unique approach, Rhodes and his collaborators discovered that intense ultraviolet light focused on a gas consisting of clusters of xenon atoms can cause the ejection of one or more tightly bound electrons — normally found in orbits close to an atomic nucleus—while leaving behind an outer shell of weakly bound electrons. The result is a highly excited form of matter called a hollow atom. When electrons refill the vacancies, they generate X-rays.

The effect occurs only for clusters of atoms. The intense electric field of the incoming ultraviolet light induces the outer electrons of a cluster's atoms to oscillate collectively. These coordinated motions facilitate the transfer of energy—a large number of ultraviolet photons—directly to an atom's inner electrons.

By a remarkable coincidence, the same effect is also responsible for channeling the ultraviolet radiation, allowing the delivery of energy directly to the atoms of a cluster. The combination of channeling with the efficient ejection of inner electrons by photons of ultraviolet light produces an ideal environment for generating X-rays.

"These two, seemingly unrelated phenomena work together to create this concentration of power," says Bernd Crasemann of the University of Oregon in Eugene. "It could be a significant factor in the development of an X-ray laser."

The researchers have found that they can maximize the emission of X-rays by adjusting the size of the atomic clusters appropriately. This result suggests the possibility of designing a new class of molecular materials optimized for the efficient production and amplification of X-rays, Rhodes says.

"If the physics works the way we want it to, we could expect an X-ray laser soon," Rhodes adds. "We're now setting up the key set of experiments to evaluate [the physics]. The next goal is to prove amplification."

"It's an approach that could conceivably be extended and made practical," Crasemann comments. "One needs to make more measurements and really confirm what's been found." —*I. Peterson*

Finding a measles-Crohn's disease link

In one A.A. Milne poem, Christopher Robin comes down with wheezles and sneezles, and everyone wonders "if wheezles could turn into measles, if sneezles would turn into mumps." Now researchers say measles may turn into Crohn's disease, a painful intestinal disorder that strikes young adults.

For some children, exposure to the measles virus in the womb or soon after birth may result in Crohn's disease, scientists report in the Aug. 20 LANCET. Researchers estimate that the illness afflicts some 250,000 people in the United States.

Swedish investigators examined the incidence of Crohn's among people born between 1945 and 1954 in central Sweden during five measles epidemics. Children born during the peak month for measles cases during an epidemic and the 2 months afterward had a 46 percent greater chance of developing Crohn's than others born during the same decade, Anders Ekbom of University Hospital in Uppsala and his colleagues report.

They found 57 cases of the illness. That number should have been 39, according to the overall incidence rate for the decade. They counted only individuals who became sick prior to age 30, when the incidence rate is the highest. The team did not find an increased rate of colitis, another intestinal disorder, during the measles epidemics.

The people who developed Crohn's or their mothers may have had either a full-blown case of measles or a latent infection, Ekbom says. Other studies have shown that a measles epidemic increases the overall number of perinatal deaths, even when the mothers have received measles vaccinations, the Ekbom team notes. Investigators have also discovered particles of measles virus in the intestines of Crohn's patients.

The measles virus may quietly station itself in the gut early in life and not cause symptoms of Crohn's until after people mature and their immune systems change, says report coauthor Matthew M. Zack of the Centers for Disease Control and Prevention (CDC) in Atlanta. At that point, the body's defense apparatus may stop treating the virus like a benign visitor, suggests Zack. Children who develop the intestinal illness may have an unusual immune system to start with, he adds.

Crohn's victims may also have a genetic predisposition to the illness, the Ekbom team notes. Fifteen percent of Crohn's patients have a family history of the disease, says Theodore M. Bayless of Johns Hopkins University School of Medicine in Baltimore, who also studies the illness.

Bayless calls the Ekbom report "another piece of evidence that would fit the hypothesis" that measles contributes to Crohn's. He is not yet convinced the hypothesis is correct, but "I'm trying to keep an open mind," he says. Bayless notes the U.S. incidence of Crohn's has remained steady. Yet it should be declining if the disease has roots in measles, since measles immunization, begun in the early 1960s, has reduced the occurrence of measles.

However, new evidence suggests that vaccination may not prove strong enough to prevent latent infections that could lead to Crohn's. Some people immunized against measles as children have come down with the disease as adults, prompting the CDC to recommend two measles shots. —*T. Adler*