government researchers and others have published epidemiological studies that they said proved that the vaccine was safe. But questions remained, because the virus kept turning cultured cells cancerous, and it kept causing tumors in animals. That debate heated up in the past decade, after researchers began finding SV40 DNA in four types of rare human cancers—the same kinds it causes in animals—and press reports emphasized that tens of millions of people could have been exposed.

The IOM committee examined the 4 decades of epidemiology to see whether people exposed to SV40-contaminated vaccine have a higher risk of cancer. Although the studies were flawed, the panel concluded, they were good enough to show that no cancer epidemic has occurred. But millions of people might have been infected with SV40 from the contaminated vaccine, the panel wrote. And the evidence is strong enough to suggest, but not prove, that the virus can sometimes cause human cancer. "We acknowledge that SV40 at least could have a carcinogenic effect, but epidemiological evidence does not suggest that it actually did," says IOM committee member Steven Goodman, a biostatistician at Johns Hopkins School of Medicine in Baltimore. Even so, he adds, "there's a body of evidence [on SV40 carcinogenicity] that has to be taken quite seriously."

The committee stressed the need for more reliable and sensitive tests to detect SV40 in human tissue, especially tests for anti-SV40 antibodies in human blood. Once those tests are devised, researchers could test human tissue samples from before 1955 for the monkey virus to ascertain whether it really came from contaminated polio vaccine. In addition, the panel said, there's enough evidence that the virus is spreading in humans that the issue should be studied further.

But overall, the IOM report "really closes the book on the discussion" of past epidemiological work, says pediatric oncologist Robert Garcea of the University of Colorado Health Sciences Center in Denver. Although SV40 might yet turn out to cause cancer in humans, the risk, if any, is "not remotely in the ballpark" of well-known carcinogens such as tobacco smoke or asbestos, adds Goodman.

The report seems to have satisfied protagonists across the spectrum, although they're drawing different conclusions. One reason, Goodman explains, is that IOM took extraordinary precautions to prevent conflicts of interest, excluding anyone who had ever sat on a government vaccine panel or received money from government or industry for vaccine research.

Virologist Janet Butel of Baylor College of Medicine in Houston, Texas, is "gratified that they recognized the biological evidence" implicating SV40 in cancer. Keerti Shah of Johns Hopkins School of Medicine, a longtime skeptic, calls the report "a positive step," although he'll need better assays before concluding that SV40 is indeed present in humans. If the National Institutes of Health follows the panel's suggestions, more money should soon be available to probe the link.

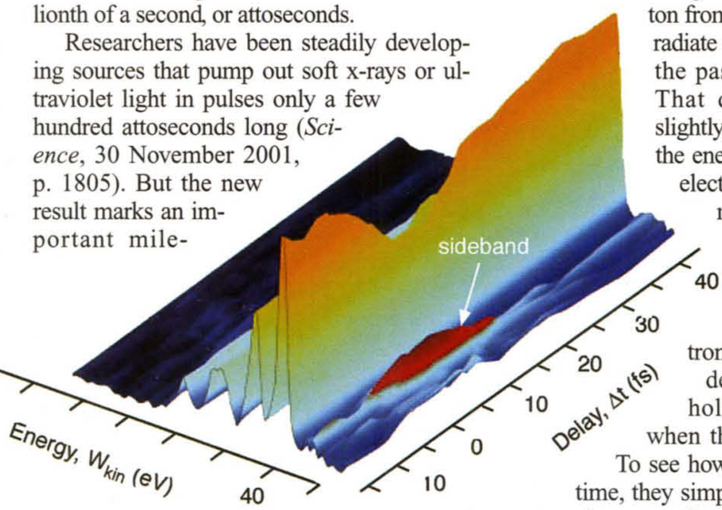
–DAN FERBER

ATTOPHYSICS

X-ray Flashes Provide Peek Into Atom Core

Using ultrashort pulses of x-rays, physicists have taken a "movie" of electrons frenetically rearranging themselves deep inside an atom. The technique opens the way for a new class of experiments in which researchers should be able to trace and control changes within atoms that take place in billionths of a billionth of a second, or attoseconds.

Researchers have been steadily developing sources that pump out soft x-rays or ultraviolet light in pulses only a few hundred attoseconds long (*Science*, 30 November 2001, p. 1805). But the new result marks an important milestone in the emerging field of attophysics, says Philip Bucksbaum, a physicist at the University of Michigan, Ann Arbor: "This is the first demonstration of a real experiment. It's not just measuring the pulse itself."



Sign of the times. In the electron spectrum, an extra peak (red) next to the main one lets physicists time changes in the atom.

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Electrons stacked deep in an atom behave a bit like gumballs piled into a vending machine: Pop one out from the bottom of the heap, and the others move to fill the void left behind. But whereas anyone with a keen eye can see the gumballs shift, the electrons rearrange themselves far too quickly to be directly observed with even the fastest particle or radiation detectors. The shuffling reveals itself, however, when the atoms are prodded with equally speedy bursts of electromagnetic radiation, Markus Drescher of the University of Bielefeld in Germany, Ferenc Krausz of the Vienna University of Technology in Austria, and colleagues report in this week's issue of *Nature*.

The researchers hit krypton atoms with a one-two punch: a blast of soft x-rays only 900 attoseconds long, followed by a flash of laser light roughly seven times longer. The x-rays stripped electrons from the krypton atoms in a process called photoionization, and some of the atoms lost an electron from a particular inner shell, creating a core hole. An electron from an outer shell then fell into the vacancy. In the process, it gave up some of its energy to yet another electron, which then flew out of the atom with a specific energy. The core holes decayed through this complicated Auger process within a few femtoseconds, and the researchers hoped to track precisely how their numbers dropped.

Through a trick of quantum mechanics, the researchers reduced the problem of clocking the decay of holes to one of counting electrons. As the Auger electron emerged, it could absorb a photon from the laser pulse or even radiate a matching photon into the passing stream of light. That quantum interaction slightly increased or decreased the energy of a fraction of the electrons—a fraction determined by the shape of the laser pulse.

By counting those energy-shifted sideband electrons, the physicists could deduce how many core holes remained unfilled when the laser pulse arrived. To see how that number fell with time, they simply varied the delay between the x-ray flash and the laser pulse. "We basically record a series of snapshots," Krausz says. "We reconstruct the motion from them" in the same way a movie recreates a moving image from still ones.

The researchers found that the krypton core holes decayed with a lifetime of about 8000 attoseconds, or 8 femtoseconds. That relatively long lifetime matches what other researchers had inferred by indirect methods. However, the new measurement marks the first time anyone has used attosecond x-ray sources and lasers to time the flickering changes within an atom directly.

"I imagine that everybody is going to adopt this technique," says John Hepburn, a chemist at the University of British Columbia in Vancouver, Canada. In the meantime, Drescher and Krausz say that their first priority is to apply the method to a shorter lived core hole, to confirm that they really can trace attosecond changes.

–ADRIAN CHO

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