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Itty-Bitty and Shrinking, Fusion Device Has Big Ideas

By KENNETH CHANG

Correction Appended

In a surprising feat of miniaturization, scientists are reporting today that they have produced nuclear fusion - the same process that powers the sun - in a footlong cylinder just five inches in diameter. And they say they will soon be able to make the device even smaller.

While the device is probably too inefficient to produce electricity or other forms of energy, the scientists say, egg-size fusion generators could someday find uses in spacecraft thrusters, medical treatments and scanners that search for bombs.

The findings, by a team at the University of California, Los Angeles, led by Dr. Seth J. Putterman, are being reported in the journal Nature.

The minifusion device accelerates hydrogen atoms and slams them together to produce helium. Unlike earlier claims of tabletop fusion - "cold fusion," in 1989, which suggested that energy could be produced by running electricity through water and metal plates, and "sonofusion," in 2002, in which collapsing bubbles supposedly heat gases to starlike temperatures - this report is not being greeted with skepticism.

"I think it's very persuasive," said Dr. William Happer, a professor of physics at Princeton.

Dr. Michael J. Saltmarsh, a retired scientist who worked at Oak Ridge National Laboratory in Tennessee, said the energy of the particles emitted by the collisions convincingly matched what was expected for fusion. Dr. Saltmarsh was one of two Oak Ridge scientists who said they were unable to detect the signatures of fusion in the 2002 sonofusion experiment.

In a commentary accompanying the Nature paper, Dr. Saltmarsh described the new device as "intriguingly simple" and added, "Indeed, in some ways it is remarkably low tech."

By contrast with the earlier claims, the U.C.L.A. researchers do not assert that their invention will provide unlimited energy. "What we've built so far," Dr. Putterman said, "no chance."

Indeed, the new device does not even produce enough energy to warm the hand. But it could be useful as a source of neutrons, the subatomic particles that are a byproduct of fusion. Because neutrons do not have any electrical charge, they can penetrate deep into matter, and that could provide a way to peer easily into luggage or cargo containers.

"We can give them a little tiny front end for a camera that can look behind things," Dr. Putterman said.

The central component of the device is a crystal of lithium tantalate, which belongs to a class of materials known as pyroelectrics. Pyroelectrics, which generate strong electric fields when heated or cooled, have long been known, possibly described as far back as 314 B.C. by a student of Aristotle.

"It's quite a surprise to see it used in this way," Dr. Happer of Princeton said.

In the experiment, the crystal, a cylinder about an inch and a quarter in diameter and a half-inch in length, was mounted inside the footlong cylinder and surrounded by a gas of deuterium, a heavy version of hydrogen. Warming the crystal about 50 degrees Fahrenheit produced a charge of 1,000 volts. That created electric fields around a tungsten tip that were so strong that they ripped electrons off the deuterium and accelerated the charged deuterium ions into a target that also contained deuterium.

When one deuterium ion hit a deuterium atom, fusion occurred. Sometimes. But because only one in a million of the collisions actually produce fusion, the device is an inefficient generator of energy.

The jet of deuterium ions could serve as thrusters for small spacecraft, and X-rays produced by electrons' being caught in the powerful electric fields might be useful for treating tumors.

The current device produces only about 1,000 neutrons a second, few enough that it would not be dangerous to use even in a physics demonstration, Dr. Saltmarsh said. The researchers plan a more powerful version by replacing deuterium in the target with tritium, an even heavier form of hydrogen, generating about 250 times as many neutrons. Additional improvements should raise the rate to a million neutrons a second.

Commercial neutron generators, which can already make a million neutrons a second, similarly accelerate deuterium into targets, but they rely on high-voltage power sources to generate the electric fields.

By relying on pyroelectric crystals instead, the U.C.L.A. research could lead to generators that are much simpler and less expensive.

"What Putterman's made is an amazing little accelerator," Dr. Happer said. "It's a version of that that doesn't need any high voltage."

Dr. Putterman says he envisions a device consisting just of an egg-size container with a crystal, deuterium gas and the target inside. Plunging the container into ice water or warming it with body heat would be enough to set off the reactions. "We can diddle temperature a mere 30 degrees and generate fields that make fusion," he said.

Correction: *April 30, 2005, Saturday:*

An article on Thursday about an experiment that produced nuclear fusion in a small cylinder misstated the voltage of the electric charge that generated the reaction. The charge, produced by warming a crystal of lithium tantalate by 50 degrees Fahrenheit, was 100,000 volts, not 1,000.

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Tabletop Fusion

Scientists have built a small nuclear fusion device triggered by changes in temperature. Not efficient enough for energy production, it produces jets of neutrons that could be used much like X-rays in screening cargo, locating land mines and exploring for oil.