Nuclear Fusion Flares on a Tabletop

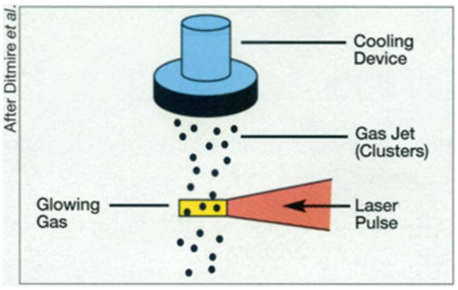
The dream of sparking tabletop nuclear fusion has become a reality, promising not commercial energy but a promising scientific payoff.

The feat took place on a lab bench only about 1 meter wide and 3.5 meters long. There, scientists zapped clusters of atoms of deuterium, or heavy hydrogen, with brief but extremely powerful laser pulses.

By focusing flickers of energy lasting much less than a trillionth of second into an extremely small volume, the laser beam heats atom clusters to tens of millions of degrees Celsius, report Todd Ditmire and his colleagues at Lawrence Livermore (Calif.) National Laboratory.

The laser pulse can strip atoms of their electrons, creating a cigar-shaped speck of hot, ionized gas, or plasma. The superheated clusters explode, bashing deuterium ions together with high enough velocity to fuse into helium ions. For each helium ion formed, the fusion reaction also spits out a neutron with a characteristic energy.

The experimenters detected emission of approximately 10,000 neutrons with the predicted energy per laser pulse. Ditmire described the experiment on March 23 to a crowded session at the Centennial Meeting of the American Physical Society in Atlanta.



After Ditmire *et al.*

Laser pulses blast clusters of deuterium atoms formed in a cooler at 100 kelvins.

"It's a great achievement," comments Gerard A. Mourou of the University of Michigan at Ann Arbor. Mourou invented a means to amplify laser pulses to extremely high intensities, thus paving the way for lasers such as the one used by the Livermore scientists (SN: 2/10/96, p. 95).

The new fusion scheme is no energy panacea, researchers insist. The laser dumps about 10 million times more energy into the plasma than the neutrons carry back out. The lost energy goes into heating ions and electrons and producing photons that make the plasma glow.

When might the new technique yield more energy than it consumes? "The answer is never," says Ditmire. For a fusion reactor to produce an energy gain, it must confine its fuel long enough, usually no less than a few nanoseconds, to ignite a self-sustaining thermonuclear burn. The plasma in the tabletop device disperses too quickly—after only 200 trillionths of a second.

Fusion energy powers the sun, the stars, and thermonuclear bombs. Scientists have labored since the 1950s to tame fusion reactions for commercial power, but practical reactors remain decades away, at best.

Sustained fusion burn is one of the goals of the stadium-size laser, known as the National Ignition Facility, that Livermore is currently building (SN: 10/19/96, p. 254). Expected to be the world's largest laser, it will hurl a mighty bolt of nearly 2 million joules of energy at a fuel capsule. By contrast, the tabletop fusion laser puts out just a tenth of a joule.

Ditmire says, however, that his team's technique will permit new types of laser fusion experiments and may lead to compact neutron sources for studying materials. —*P. Weiss*

Solvents' link to birth defects bolstered

Since 1985, researchers at the Hospital for Sick Children in Toronto have offered a program called Motherisk for women in their child-bearing years who are concerned that they have been exposed to harmful chemicals or radiation.

Now, potent evidence that Motherisk researchers accumulated over 10 years indicates that many women have good cause for worry.

Pregnant women exposed to organic solvents are indeed much more likely to have a deformed baby than unexposed women are, the scientists report in the March 24/31 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION.

Between 1986 and 1996, the investigators tracked and recorded the outcomes of pregnancies in 125 pregnant women exposed to organic solvents at workplaces such as factories, laboratories, graphic design businesses, and print shops. The solvents included phenols, xylene, acetone, and trichloroethylene.

The women were exposed for at least 4 months of their pregnancy, including the entire first trimester, says study coauthor Sohail Khattak, a pediatrician and clinical pharmacologist at the hospital. The first trimester is a critical time during which organs form in a fetus, he explains.

Khattak and his colleagues also tracked 125 pregnant women who had sought advice from Motherisk doctors for what turned out to be harmless exposures to chemicals, such as taking acetaminophen during pregnancy. These women were matched to the exposed group by age and lifestyle.

Most of the women in both groups were referred to Motherisk by their doctors, but some came in on their own.

Of 113 live births to the women exposed to the chemicals, 13 babies—12 percent of births—had major malformations, such as deafness or a heart defect. Five other babies had minor birth defects. Twelve of the pregnancies ended in miscarriage or abortion.

Women in the control group had 115 live births, but only one baby had a major birth defect and one had a minor deformity.

Among healthy mothers such as these, the expected rate for major abnormalities stands at 1 to 3 percent.

One new finding might provide a warning sign. Of the 125 exposed women, 75 had complained during pregnancy that organic chemicals were giving them headaches or breathing problems. Of the 13 major defects in the exposed group, 12 occurred in babies born to these women.

"We were quite amazed at the degree of effect we found," Khattak says.

The exposed women also had nine premature births, compared with three in the control group. This is the first study to measure premature births among women exposed to organic solvents, Khattak says.

Earlier tests in animals had shown that chemicals inhaled by pregnant rodents can cross the placental barrier to damage their young. Some studies of human mothers hinted that exposure to organic solvents might be to blame for birth defects, but others did not.

Because the Motherisk researchers identified the exposed women early in pregnancy, their work avoids the errors and biases of studies that later ask mothers to recall their exposures during pregnancy, says Richard K. Miller, an obstetrician and gynecologist at the University of Rochester (N.Y.) Medical Center.

"This paper from Motherisk is certainly the benchmark for examining the relationship between maternal toxic [exposure] and birth defects," he says. Its results will change how doctors counsel pregnant women regarding occupational risks, especially those that cause symptoms in the women, he predicts. —*N. Seppa*