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Brutal Bubbles: Collapsing orbs rip apart atoms

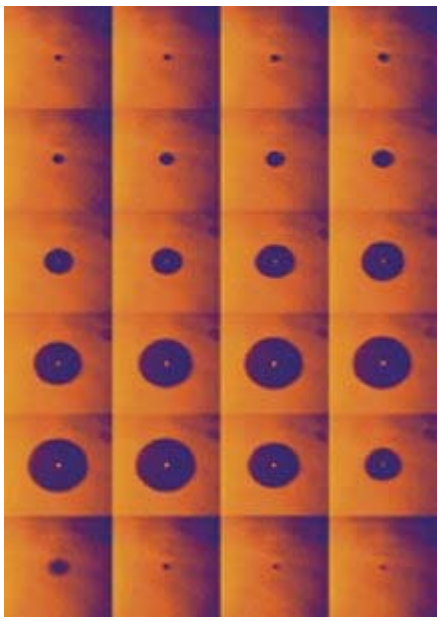
Peter Weiss

Fill a flask with liquid, rattle it with ultrasonic waves, and hellish microcosms can form within the fluid. Tiny gas bubbles swell and then implode with a fury now revealed to be extreme enough to strip electrons from atoms trapped in the collapse.

The Illinois chemists who have detected that atomic destruction for the first time have also directly measured temperatures of the imploding bubbles. Some of these register at least 15,000 kelvins, a temperature about three times as hot as the Sun's surface.

Researchers have long known that the collapse of ultrasonically generated bubbles emits flashes of light—a phenomenon called sonoluminescence (SN: 3/6/04, p. 149: Available to subscribers at http://www.sciencenews.org/articles/20040306/fob5.asp). Some scientists even claim that thermonuclear fusion can occur in the implosions.

To explain these phenomena, some physicists have suggested that a plasma—a vapor of electrons and ions—forms in imploding bubbles. No one, however, had evidence of such a condition. Now, David J. Flannigan and Kenneth S. Suslick of the University of Illinois at Urbana-Champaign report light emissions suggestive of a plasma.



SQUASH CAUGHT. In each column of microsecond snapshots, a gas bubble swells, then collapses to about the size of a blood cell. Bright central spot is an artifact of the

Scientists often probe temperatures and other properties of inaccessible objects, such as distant stars, by analyzing the spectra of light the objects emit.

In the past, spectra of sonoluminescence flashes in

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single bubbles had revealed little, in part because the bubbles may have contained too many atoms and molecules of different energies to allow any discernible sign of a plasma to come through, says Suslick. Furthermore, quantum mechanical effects blur the light pattern.

lighting.
Suslick

To minimize problems, he and Flannigan kept the bubble chemistry simple. They injected inert argon gas into a liquid—concentrated sulfuric acid—whose vapor scarcely enters bubbles.

In their implosion experiments, the researchers detected emissions from argon atoms excited to high energies. Those atoms had been hit by high-speed electrons barreling out of tiny "plasma cores," the team argues in the March 3 *Nature*.

Light doesn't emerge from a plasma's interior. "As with a star," notes Suslick, "you only can measure the temperature of the surface." Such a hot plasma surface, however, suggests "extremely high temperatures at the core," comments William C. Moss of Lawrence Livermore (Calif.) National Laboratory.

Indeed, the new data provide "indirect evidence" of temperatures of hundreds of thousands of degrees K inside the imploding bubbles, adds Lawrence A. Crum of the University of Washington in Seattle.

Rusi P. Taleyarkhan of Purdue University in West Lafayette, Ind., a researcher who has reported that imploding bubbles produced by ultrasound can host what he calls sonofusion, finds the new results encouraging. "High-temperature plasma states … are a necessary precondition for significant and detectable thermonuclear fusion," he says.

Suslick acknowledges that a plasma is a step toward fusion. However, he says, the new work "can neither confirm nor deny" such claims because his experiment and Taleyarkhan's fusion experiments had too many technical differences to permit meaningful comparisons.

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