Tiny Bubbles Implode With the Heat of a Star

By KENNETH CHANG

Published: March 15, 2005

When the force of sound waves implode tiny bubbles within a liquid at room temperature, the surface of the bubble can reach temperatures at least 25,000 degrees Fahrenheit, more than twice as hot as the surface of the sun, scientists reported this month.

The center of such a bubble may be even more astonishingly hot.

The scientists, at the University of Illinois, did not speculate just how hot the bubble became, but said they had managed to create a state of matter called plasma inside the bubble. In it, some of the electrons have been stripped off the atoms.

"This is the first definitive proof of the existence of a plasma" during this kind of bubble implosion, said one of the scientists, Dr. Kenneth S. Suslick, a professor of chemistry at Illinois.

Their finding supports the intriguing notion that it may be possible to compress these bubbles so violently that vapor molecules in them are heated to multimillion-

David J. Flannigan and Dr. Kenneth S. Suslick/University of Illinois

A cloud of bubbles collapses near a high-intensity ultrasonic horn.

degree temperatures.

The phenomenon of imploding bubbles, called sonoluminescence because it emits a flash of light as the bubble collapses, has been increasingly studied since it was discovered 15 years ago.

In 2002, scientists performing an experiment at Oak Ridge National Laboratory in Tennessee even reported that they had used the technique to fuse hydrogen atoms into helium - the process that powers the sun. That experiment did not measure the bubble temperatures, but detected byproducts of fusion.

The Oak Ridge scientists said each burst produced only a smidgen of energy, but they speculated that it could develop into a practical power source.

Most other scientists remain skeptical of that claim, because the experiment has not yet been reproduced elsewhere, but the science increasingly appears at least plausible.

"I'm becoming skeptical about my earlier skepticism," said Dr. Lawrence A. Crum, a professor of electrical engineering at the University of Washington. But he added, "I won't say it's likely."

The latest results, reported in the journal Nature, did not offer signs of fusion. Rather Dr. Suslick and David J. Flannigan, a graduate student, provided tantalizing hints that these bubbles could reach temperatures high enough for fusion.

In the experiment, they created a single bubble in a jar of sulfuric acid and observed as sound waves above 18,000 cycles per second resonated on the liquid, causing the bubble to grow and collapse over and over.

Sulfuric acid has a lower vapor pressure than water, which had been used in most previous sonoluminescence experiments, allowing the bubble to collapse more quickly and produce flashes 3,000 times as bright as those seen in earlier sonoluminescence experiments.

The sulfuric acid contained trace amounts of argon gas, which emitted specific colors of light as the bubble collapsed, allowing the researchers to determine the temperature.

Dr. Suslick and Mr. Flannigan also detected colors from atoms that had had some of their electrons stripped away, forming a plasma, which would be a

1. Under Bush, a New Age of Prepackaged TV News
2. Does the Affordable Paris Bistro Still Exist? Oui.
3. Op-Ed Contributor: A Family Tree in Every Gene
4. Ante Up at Dear Old Princeton: Online Poker Is a Campus Draw
5. Op-Ed Columnist: Dish It Out, Ladies

Go to Complete List

Business
nytimes.com/business

Meet Disney's new chief

Also in Business:
- How are the North Pole and Imax connected?
- Did your car get a low crash test rating?
- The last days of Enron

prerequisite for fusion to occur.

"I think it's a significant advance," Dr. Crum of Washington said.

To form some of the charged atoms seen in the Illinois experiment, he said, at least some electrons flying out from the center of the bubble would have had an effective temperature greater than 250,000 degrees.

Dr. Suslick agreed that some of the electrons did have that much energy, but he said that the overall temperature - the average energy of all the electrons - might not have been that high.

His findings, he added, do not prove nor disprove the controversial Oak Ridge experiment, which employed a very different setup. For example, the Oak Ridge researchers used acetone, which has a higher vapor pressure, but were also able to generate much stronger sound waves.

"Will it lead to desktop fusion generators?" Dr. Suslick said. "I can't answer that yea or nay right now."

The only known attempt to reproduce the Oak Ridge experiment was by Dr. Seth Putterman of the University of California, Los Angeles, whose the work was financed by an unusual source, the BBC. For an episode of its "Horizon" science series that focused on the Oak Ridge experiment, the BBC gave Dr. Putterman $70,000 to try to replicate it.

"I'm desperate for money, and here's a chance to infuse my laboratory with overhead-free money," Dr. Putterman said. "We had fun."

But his experiment saw no sign of the fusion-generated neutrons that had been reported.

Dr. Rusi P. Taleyarkhan, the head of the Oak Ridge experiment, said there were notable differences between his set-up, which cost close to $1 million, and the one put together by Dr. Putterman. "Sometimes you get what you pay for," said Dr. Taleyarkhan, now a professor of nuclear engineering at Purdue.

Dr. Putterman said the Defense Department was planning to spend $800,000 - $350,000 for his group at U.C.L.A., $350,000 for Dr. Taleyarkhan and $100,000 for Dr. Suslick's group at Illinois - for a full-fledged effort to repeat the original experiment.

Dr. Taleyarkhan said, however, that he not yet agreed to participate. "At one point, I did consider going forward," he said, "and we might still accept."

RELATED ARTICLES

- Physicist Is Awarded the Templeton Prize in Spiritual Matters (March 10, 2005)
- CONNECTIONS; Truth, Incompleteness And the Gödelian Way (February 14, 2005) $
- Arts, Briefly; Relativity in Dance (January 5, 2005)
- IN THE SCHOOLS; A Lofty Resume, But Firmly Rooted (June 20, 2004) $

Find more results for Physics

TOP SCIENCE ARTICLES

- Mother Culture, or Only a Sister?
- For Troops, Home Can Be Too Close
- Power Producers Seek Latest Models of Nuclear Reactors
- Listening to the Beat of the Bomb

Go to Science