Bubble fusion dispute reaches boiling point

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Claims that nuclear fusion has been achieved in a 'table-top' experiment have become mired in controversy before the findings have even appeared in print.

The authors of the paper believe their experiment, reported in this week's issue of *Science*, is a breakthrough that might one day help to fulfil the elusive dream of fusion power. But opponents dispute the findings and say that the paper carries echoes of the 'cold fusion' fiasco of the late 1980s, in which two researchers claimed to have achieved nuclear fusion using an electrolytic cell.

The authors of the paper, led by Rusi Taleyarkhan of the Oak Ridge National Laboratory in Tennessee, claim to have achieved fusion inside a vibrating beaker filled with acetone, in which the hydrogen atoms were replaced with deuterium. This is a heavier isotope of hydrogen containing a neutron, in addition to a proton, in its nucleus.

The researchers bombarded the sample with neutrons to 'seed' the formation of tiny bubbles. When they shocked the beaker with waves of sound, bubbles formed, expanded and suddenly collapsed, releasing flashes of light. This overall phenomenon, known as sonoluminescence, is thought to cause a momentary surge in temperature inside the bubbles that some physicists have argued might be sufficient to sustain nuclear fusion reactions.

This is exactly what Taleyarkhan and his colleagues claim to have recorded. They argue that — under the right experimental conditions — the temperature in the bubbles rose to more than 1 million kelvin, allowing deuterium nuclei to undergo fusion reactions. As evidence, the team cites the production of tritium — a form of hydrogen containing two neutrons — and high-energy neutrons (R. P. Taleyarkhan *et al. Science* **295,** 1868–1873; 2002).

But not everyone is convinced, and some of the loudest critics are also at Oak Ridge. As part of an internal review, nuclear physicists Dan Shapira and Michael Saltmarsh replicated the experiment last July while the paper was being reviewed for publication. "We substituted our own detector and a much more sophisticated data-acquisition system to see if we could see what they saw," says Saltmarsh, "and we didn't."

Saltmarsh and Shapira claim that the neutron production is an order of magnitude too small to be consistent with the tritium production reported by Taleyarkhan. They also argue that the paper does not prove that the neutron emissions coincide with the sonoluminescent flashes.

After completing reports to the original authors and Oak Ridge management, Saltmarsh and Shapira put the matter out of their minds. "We thought this was all put to bed," Saltmarsh says.

P. PLAILLY/EURELIOS/SPL

Bubble trouble: a team of physicists claims to have achieved nuclear fusion inside small bubbles created with apparatus similar to that shown above, but the results are facing strong challenges.

But three weeks ago, they found out that Taleyarkhan's paper was going to appear in *Science*. Saltmarsh and his colleagues scrambled to publish their results, but their data had not been peer reviewed. "It would have been nice to get our results published at the same time, but we had no warning," Saltmarsh says.

Heated debate

Nonetheless, their results, posted on an Oak Ridge website, are cited in Taleyarkhan's paper together with a similar citation to the fusion team's rebuttal, which is also posted on the Internet. These non-peer-reviewed articles are referred to in the final paper at the insistence of *Science*'s editorial team, following representations from senior managers at Oak Ridge.

Other experts are also sceptical of the fusion experiment's results. "I've reviewed this paper from its first version, and I unfortunately concluded that the experimental technique is flawed," says Seth Putterman of the University of California, Los Angeles.

Putterman asserts that the beam of neutrons used by Taleyarkhan's team to seed the bubbles would be indistinguishable from any neutrons produced in a fusion reaction. "The worst way to look for neutrons is to flood your room with them," he says.

He also has serious concerns about the tritium measurements, arguing that deuterated acetone would naturally contain some tritium, which could become concentrated through processes that have nothing to do with fusion. Even in advance of *Science*'s early release of the paper on 4 March, Putterman's concerns were being echoed by other leading physicists.

But the authors fiercely defend their paper. Richard Lahey of the Rensselaer Polytechnic Institute in New York state, a co-author on the paper, dismisses Putterman's comments about neutron detection. "We spent hours worrying about that," he says, adding that he believes the neutrons produced by fusion would have a higher energy than those used to seed the bubbles.

Lahey also says that the team accounted for any background levels of tritium present in their sample, and detected a clear excess of the isotope during the experiment.

As the debate rages on, Oak Ridge officials have found an uncomfortable seat on the sidelines. "I think it's an exciting experiment," says Lee Riedinger, deputy director of Oak Ridge. "But to be honest, I need to see another measurement before I can decide if the conditions are there for fusion."

Riedinger notes that interest generated by Taleyarkhan's 'table-top' fusion is reminiscent of the furore that surrounded the 1989 'cold fusion' experiment by Stanley Pons and Martin Fleischmann of the University of Utah.

But he points to two important differences: the current paper has undergone extensive peer review, and most physicists agree bubble fusion is, at least in principle, possible. He hopes that the Saltmarsh paper will soon be peer-reviewed and published. ■

- www.ornl.gov/sisite
- www.rpi.edu/~laheyr/SciencePaper.pdf