Hopes for nuclear fusion continue to turn cool

- Press conferences continue
- Verification mostly halting

Washington

IF the withdrawal by Stanley Pons and Martin Fleischmann of the cold fusion paper submitted to *Nature* bolstered rising scepticism, enough happened this week to keep hopes alive. Claims of successful fusion arrived from California, India and Brazil, and Pons himself hinted at new experimental evidence. But at the press conferences at which the announcements were made, hard data have been lacking and conclusions unclear; still no verdict can be reached.

One positive note is the publication in this issue of the more modest claim by Steven Jones and his colleagues, at Brigham Young University, who give evidence for a small but significant increase in neutron flux when current is passed through a palladium cathode in a suitable electrolytic cell. Jones and his group believe that fusion is occurring, but at a level much below what Pons and Fleischmann need to explain their energy production rate.

That claim is now at the centre of the debate. Neither in the published paper nor in the version submitted to *Nature* is there enough detail for readers to make their own estimations of the workings of the electrolytic cells. That and some other relevant issues are dealt with elsewhere (see pages 701, 705, 710 and 711).

At a press conference in Salt Lake City on 17 April, Stanley Pons announced a qualitatively new piece of supporting evidence: mass spectroscopy of the gases evolving from a working fusion cell revealed the presence of ^4He in quantities consistent with the reported energy production, if all deuteron–deuteron fusions produce ^4He rather than tritium and a proton or ^3He and a neutron.

Cheves Walling, a colleague of Pons, says that gas from the cell was sampled and analysed, and a production rate of 10^{12} atoms per second was deduced after the total gas flow rate had been figured in. This rate of helium production is much greater than in the 1926 'cold fusion' experiments (page 692), in which about 10^{10} atoms were detected after several hours.

Walling and a colleague, John Simons, have submitted to the *Journal of Physical Chemistry* a theoretical paper suggesting how the high density of electrons in the palladium lattice could allow the high-energy photon expected, with a ^4He nucleus, to be converted into lattice vibrations and thus heat. Although Walling describes the theory as 'qualitative', he says that enhancements by many orders of magnitude of this normally rare fusion mode could be achieved.

At the 17 April press conference, Pons addressed an issue which has caused disquiet since it was brought up by Harold Furth, director of the Princeton University Plasma Physics Laboratory, at the recent meeting of the American Chemical society in Dallas, Texas (*Nature* **338**, 605; 1989) — the lack of a direct comparison between an electrolytic cell containing heavy water and one containing ordinary water. Pons tantalized his audience by indicating that preliminary results from just such a comparison suggested an "unexpected" production of heat in the ordinary cell. There are no numbers.

A similar comparison between 'light' and 'heavy' electrolytic cells was described at Stanford University on 18 April by Robert Huggins, of the Materials Science Department. He said that when two cells, identical except that one used H_2O and the other D_2O, were run side by side with the same voltage applied, the heavy-water cell consistently ran the hotter by as much as 15 per cent. Huggins says that differences in the specific heat of heavy and light water, or in the diffusion rates of hydrogen and deuterium into the palladium electrode, are not large enough to explain the results.

Other groups are attempting similar comparisons, but none has yet reported success; Huggins says that there are "a couple of features" in his set-up that others may have missed, but these will not be revealed until a special session of the meeting of the Materials Research Society, scheduled for the evening of 26 April in San Diego.

In India, two groups claim to have achieved cold fusion in electrolytic cells similar to those used at the University of Utah. A third group, at the Bhabha Atomic Research Centre (BARC) in Bombay, is setting up a large-scale electrolysis reactor expected to produce results towards the end of May.

C.K. Mathews and colleagues at the Indira Gandhi Atomic Research Centre (IGARC) at Kalpakkam near Madras have reported neutron production from electrolysis of heavy water using a platinum anode and a titanium cathode. The team used an electrolyte of nickel and palladium chlorides at 0.2 per cent concentration rather than the lithium salt used by Pons and Fleischmann. "We observed a 30 per cent increase in neutron flux over the background level, suggesting that fusion was taking place", said IGCAR director Dr C.V. Sundaram. No measurements were made of energy output. Sundaram said the results were not always reproducible because the experimental parameters had not been optimized.

In an almost identical set-up at the Tata Institute of Fundamental Research in Bombay, researchers claimed to have observed energy amplification, but they did not look for neutrons. Professor K.S.V. Santhanam and his colleagues in the chemical physics group said that passage of 0.25 watts of electrical power through the cell produced one watt of thermal output at the titanium cathode, whose temperature rose to 80° C in a sustained reaction. Heavy water mixed with sodium chloride was used as the electrolyte and platinum as anode in this experiment.

BARC's director, Dr P.K. Iyengar, said his group is setting up a much larger version of the Utah experiment with sophisticated instrumentation for measuring heat as well as fusion products. Results are expected in a month. But Iyengar, a well-known reactor physicist, is sceptical.

India is one of the few countries producing heavy water in commercial quantities and may therefore have an advantage if cold fusion is real. BARC is also interested in cold fusion as an inexpensive neutron source, which could be used, instead of fast-breeder reactors, to transmute India's 360,000-tonne reserve of thorium into uranium-233 fuel. But BARC's spirit has been dampened by reports that, whatever happens inside palladium, it does not produce a large neutron flux.

In Brazil, two groups have announced, by the now-traditional press conference, that they have obtained fusion reactions while trying to replicate the Utah experiments. The first team to report, from the Physics Institute of the University of São Paulo, said on 19 April that it had detected neutrons at twice the background level. Spero Penha Morato says that only a deuteron–deuteron reaction could account for this excess of neutrons, but the team was not equipped to measure heat production.

The second announcement, on 29 April, from the Institute of Space Research (INPE) in São Jose dos Campos in São Paulo state, says that a group headed by Gerson Otto Ludwig and known for work on fusion by magnetic confinement has reported two separate neutron bursts during a 100-hour experimental run. The first burst, after ten hours, had an intensity of ten times background; the second, after 35 hours, four times. At another press conference on 21 April, the same group announced it had detected ^3He, thus proving that fusion reactions had occurred. □