Fusion Fury: Experiments, Theories Grow

He could have charged admission. In a Dallas arena more suited for rock concerts, B. Stanley Pons of the University of Utah in Salt Lake City told a sometimes cheering crowd of more than 7,000 at the American Chemical Society meeting last week that he and British colleague Martin Fleischmann of the University of Southampton stand by their March 23 claim of achieving nuclear fusion in a tabletop experiment at room temperature with up to an eightfold net payoff of energy. Most scientists still await further evidence.

Research groups in Italy, the Soviet Union, California and Texas have reported findings that seem to support both Pons' and Fleischmann's claim and a similar but less spectacular claim on March 31 by Steven E. Jones of Brigham Young University in Provo, Utah (SN: 4/1/89, p.196; 4/8/89, p.212). Many other groups continue what so far have proved to be unsuccessful attempts to replicate the seemingly elementary experiments, which involve simple electrolytic cells that split water into its atomic elements by passing electrical current between two metal electrodes immersed in the liquid.

Both Utah groups run their cells with hydrogen-absorbing metals, such as palladium and titanium, and "heavy water," which contains one oxygen atom and two atoms of deuterium, hydrogen's double-heavy isotope. In ways theorists may now be uncovering, huge amounts of positively charged deuterium nuclei pack into the metal electrode in such densities and arrangements that some of them allegedly circumvent their natural electrical repulsions and fuse.

According to conventional theory, two deuterium nuclei fuse into an unstable helium nucleus, which contains two protons and two neutrons. This nucleus regains internal quietude by immediately ejecting a fast-moving proton or neutron and becoming a tritium nucleus (a radioactive, triple-heavy hydrogen isotope) or a neutron-deficient helium nucleus. Mysteriously, the Pons/Fleischmann fusion cells emit a mere billionth of the neutrons that would be expected if the normal deuterium-deuterium fusion reactions caused the heat the cells liberate.

Also disconcerting to observers is that Jones' experiments emit a barely audible whisper of neutrons and no detectable heat. This discrepancy may result from the different ways the two groups made the heavy water more conductive. Pons uses lithium metal, which makes the water basic. Jones' initially reported experiments involved certain metal salts, which make the water acidic. Physicist E. Paul Palmer, Jones' co-worker, says the group had problems with materials plating onto their titanium foil electrodes, perhaps making them inefficient.

At the Dallas gathering, many scientists objected that no control experiment had been done using regular water. If results from control runs differed significantly from those of the heavy-water experiments, the case for a new route to fusion would be greatly strengthened, says Harold Furth, head of the Princeton (N.J.) University Plasma Physics Laboratory. Pons said this week that he had done control runs and observed an unspecified amount of excess heat. Stanford University researchers also have done both experiments. They report measuring a net energy gain in heavy water but no excess heat using regular water.

Fusion fury circles the globe. According to an April 17 report by the Italian news service ANSA, physicist Francesco Scaramuzzi of the Frascati Laboratory near Rome observed rates of about 1,000 neutrons per second (many times normal background levels) emerging from an experimental fusion apparatus that required no electrochemistry to achieve fusion. According to the science attaché of the Italian embassy in Washington, D.C., Scaramuzzi assembled 50 cubic centimeters of titanium into a compact geometry and then immersed the assembly in deuterium gas.

Nuclear chemist Glenn T. Seaborg of the University of California's Lawrence Berkeley Laboratory told SCIENCE NEWS he and others had suspected this experiment would prove interesting, since the supposed new cold fusion should depend on the presence of deuterium in the metal, not on the way deuterium enters.

Other findings, if valid, lend further support. The Soviet news agency Tass reported April 12 that physicist Runar Kuzmin and co-workers at Moscow University had confirmed the U.S. cold-fusion experiments. The scientists said they observed neutrons three to five times above background levels and the boiling of heavy water in their electrolytic cells. Tass said Moscow University will begin a major research program into the new form of fusion.

Two research groups at Texas A&M University at College Station reported measuring modest net energy gains in their Pons-Fleischmann-type experiment. Scientists at Georgia Institute of Technology in Atlanta also had reported measuring neutron fluxes six to 10 times higher than background, but retracted the report on April 14 after discovering problems with their neutron counter.

Theorists are joining the drama. Although both Pons' and Jones' teams have their own ideas to explain electrochemically induced cold fusion, researchers at Massachusetts Institute of Technology, the University of Utah, Princeton University and Argonne (Ill.) National Laboratory have posited theories to explain – or explain away – the alleged new type of cold fusion.

In four papers submitted for publication, MIT physicist Peter L. Hagelstein outlines a theory that he says could explain how pairs of deuterium nuclei can fuse inside the palladium metal lattice into highly excited helium nuclei without then either fragmenting or giving off high-energy gamma-rays – the results of such fusions when they occur at superhigh temperatures in plasmas.

In a prepared release, Hagelstein condenses his theoretical case into 14 conclusions. His theory suggests cosmic rays or other particles trigger chains of fusions inside a palladium lattice. Deuterium pairs fuse into stable helium nuclei; energy that normally would appear as high-energy gamma-rays instead shunts directly into the metal lattice and is indirectly observed as heat.

In addition, Hagelstein summons a series of lattice vibrations and energy-flow mechanisms to explain, among other things, how electrolytic cells using palladium electrodes and heavy water might greatly enhance the negligible background rate of fusion and why "the direct coupling of coherent fusion energy into electrical energy with some efficiency seems to be likely."

Keith Johnson, also at MIT, offers another idea. His theory does not rule out low levels of fusion, but he suggests that non-nuclear processes can account for most, if not all, of the heat observed. Deuterium enters the metal lattice and forms into what resembles its own sublattice within the host metal lattice, Johnson says. This produces strain in the sublattice, which is relieved when the deuterium nuclei begin to "flap around rapidly." As a result, weak deuterium-palladium bonds rapidly form and break, releasing what Johnson says could be enough heat to account for Pons' and Fleischmann's observations. Argonne chemist Carlos Melendres says his calculations show Pons and Fleischmann need no fusion to account for their actual heat measurements.

Whether or not the scientific jury ultimately validates the new cold-fusion claims, many physicists and chemists agree that Pons, Fleischmann, Jones and their respective associates have discovered intriguing new physical phenomena that tantalize, excite and beg for explanation. *– I. Amato*