SCIENCE NEWS of the week

Fusion Claim Electrifies Scientists

The stakes couldn't be much higher. On March 23, two highly respected chemists parachuted onto the center stage of physics with their public announcement of a new bench-top method for harnessing the power of nuclear fusion, the energy-releasing process that makes stars shine and empowers thermonuclear weapons.

If others confirm their claims, the scientists may enjoy a Nobel prize and a standing ovation in Stockholm for a scientific performance that might one day provide an almost unlimited supply of energy. If they emerge as false prophets, colleagues say the two could spend years resurrecting their scientific reputations, which their unorthodox announcement — called premature by some — put at risk.

In a press conference in Salt Lake City, the scientists — Martin Fleischmann, an electrochemist at the University of Southampton in England, and chemist B. Stanley Pons of the University of Utah — reported unpublished research into what they describe as a new, simple and technologically feasible method of fusing small atomic nuclei to unleash vast amounts of energy. Pons told Science News they already have passed the break-even point, where more energy is released than used to force fusion, by as little as 111 percent or as much as 800 percent.

Though remaining open to the possibility that the chemists have indeed found a back door to controlling nuclear fusion for generating heat and power, most fusion scientists strongly question the claim. Nearly immediately after the announcement, and with only media reports to inform and guide them, researchers began voicing skepticism about the findings while rushing to duplicate the seemingly simple experiments.

These efforts, hampered by a paucity of experimental details revealed during the press conference, failed to quickly confirm the chemists' results. As Fleischmann and Pons have warned, their experiments are potentially dangerous because they could produce energetic neutrons at hazardous levels. The fact that Pons and Fleischmann are alive, despite their claims of achieving power levels others calculate would release a lethal spray of neutrons, tripped alarms in the minds of many scientists. "The palladium should have become radioactive and everything else around it should have become radioactive," remarks nuclear chemist Glenn T. Seaborg of the University of California's Lawrence Berkeley Laboratory.

Unlike nuclear fission, in which energy is liberated when heavy elements such as uranium split into lighter ones, nuclear fusion unleashes energy when the nuclei of lighter elements fuse into heavier ones. To achieve these unions, the enormous repulsive forces between positively charged nuclei must be overcome or circumvented. To date, most fusion researchers have tried to copy the celestial version of fusion using deuterium and tritium atoms (the heavy isotopes of hydrogen) as fuel. The tactics involve expensive, huge and elaborate machinery designed to overcome nuclear repulsion by heating nuclei to about 100-million°C while confining them long enough and at high enough densities for the nuclei to fuse into helium atoms.

More recently, researchers have explored less technically daunting "cold fusion" tactics. The most developed of these involves muons — negatively charged particles about 200 times heavier than electrons. Muons produced in accelerators can serve as surrogate electrons, which assemble into exotic, more closely packed two- or three-atom molecules of deuterium and/or tritium nuclei. In such cramped atomic quarters, fusion becomes more likely via a quantum mechanical process, in which nuclei tunnel through the huge energy barrier that normally keeps them separated.

But if Fleischmann's and Pons' version of "cold fusion" isn't just "a horrible chain of misinterpretations and accidents" — which Fleischmann acknowledged as a possibility in an interview with Science News — even this so-called muon-catalyzed fusion may join the ranks of good ideas put to rest by better ones. To achieve cold fusion without muons, he and Pons used palladium, a remarkable hydrogen-hoarding metal, and the well-known process of breaking water molecules into their oxygen and hydrogen components by passing an electric current through the liquid. The researchers use heavy water made with deuterium instead of hydrogen. As usual, oxygen collects and forms into bubbles of gas at the positively charged anode, which is a coil of platinum wire.

But the events Fleischmann and Pons say occur at their negatively charged palladium cathode nestled inside the coil have compelled dozens of scientists to defect to fusion research, at least temporarily. As evidence that fusion is happening, the two chemists say the heat generated in their cells is about 100 times higher than would be possible if only conventional chemical and physical processes were at work. In an early experiment, Fleischmann says, the bottom half of the palladium electrode "vaporized" and the researchers observed "high neutron counts" in the laboratory. They now perform safer, slower, scaled-down experiments. In some, a month may pass before they see evidence of fusion, Fleischmann says.

In addition to the surprisingly large amounts of thermal energy, the researchers reported observing increased amounts of tritium, an expected by-product of normal fusion of two deuterium nuclei, and specific high-energy gamma rays produced, they say, by neutrons carrying an amount of kinetic energy one would expect from fusion reactions. If this is true, many researchers say, the observations would provide solid evidence of fusion inside the palladium electrode. "The claim that they have found neutrons and tritium is powerful evidence," notes Hendrik J. Monkhorst, an expert in muon-catalyzed fusion at the University of Florida at Gainesville.

According to Pons and Fleischmann, the new fusion mechanism involves two of palladium's best features: its tendency to absorb massive amounts of positively charged deuterium nuclei into its crystal lattice, and its sea of electrons that shield the positive charges of the nuclei from one another. In combination, these properties of palladium circumvent and disarm the repulsion between sets of deuterium nuclei, allowing them to fuse.

But these "conventional" fusion reactions may account for only a small fraction of the nuclear reactions occurring. "It has become apparent gradually that although we do in fact see the accumulation of tritium and we do see neutrons, they are only a small part of the overall picture," Fleischmann said in an interview. "So there must be other processes going on. The unsatisfactory part about this whole business is that we do not yet really know what those processes can be."

Normally, scientists "go public" only after subjecting their work to the scrutiny of their peers at research conferences or submitting articles to professional journals. The New York Times reported University of Utah's Vice President of Research James J. Brophy as saying the university called the press conference to offset inaccuracies that might appear in an account that a Utah reporter was about to publish. Pons told Science News that "the seminal paper" describing their work had been submitted to editors of the Journal of Electroanalytical Chemistry and Interfacial Electrochemistry on Saturday March 11 and accepted for publication two days later. Pons says no publication date has been set, and he refused to release a copy of the paper. The researchers say they have submitted a related article to Nature. — *I. Amato*