AMERICAN INSTITUTE OF PHYSICS
335 East 45th Street
New York, NY 10017-3483
Tel. 212-661-9404

NEWS-RELEASE

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For more information please
contact Phillip Schewe at
(212) 661-9404, ext. 520

Cold Fusion, Pulsars, and Z Particles at the APS Baltimore Meeting

The 1989 Spring Meeting of The American Physical Society (APS) in Baltimore featured two sessions devoted to the subject of cold fusion. Other highlights of the meeting, to be discussed below, include papers on supernova 1987A, the production of Z particles at the Stanford Linear Collider, and electron-positron annihilation at the center of the Milky Way.

COLD FUSION

The nearly forty speakers at the cold fusion sessions offered very little support for the experiment performed at the University of Utah by B. Stanley Pons and Martin Fleischmann, who claimed that they had observed an excess of heat and the production of neutrons from room-temperature fusion reactions in an electrolytic cell. The following is a summary of the cold fusion results presented at the meeting. (Pons and Fleischmann themselves declined an invitation to present their work at the meeting.)

Caltech Results

Chemist Nathan Lewis of the California Institute of Technology delivered perhaps the heaviest blow against the Utah claim. His team attempted to duplicate the Utah results using a variety of electrodes (including cast Palladium), a variety of electrolytic solutions, a calorimeter for measuring heat, and a system of detectors for measuring possible fusion products such as neutrons, helium, tritium, and gamma rays. Lewis reported that after weeks of recording data his team had observed no evidence for cold fusion.

Furthermore, Lewis believes he knows where Pons and Fleischmann went wrong. Their report of excess heat, Lewis claims, can be attributed to the Utah experimenter's failure to stir their solution and to their miscalculation of the cell voltage. Lewis asserted that the Utah claim of a four-watt output for a one-watt input was based not on any direct measurement but on a (mistaken) calculation. The helium measured by Pons and Fleischmann, Lewis said, probably came from the ambient air in the cell.

Another Caltech scientist, Steven E. Koonin, a nuclear physicist, claimed that the gamma rays (presumably from neutrons produced in fusion reactions) reported by Utah were possibly coming from the decay of naturally occurring radon in the earth. Koonin's paper concentrated on new calculations of the intrinsic reaction rate of fusion rates between various hydrogen isotopes. He reported two surprising conclusions: (1) the inherent rate of deuterium-deuterium fusion reactions is some hundred million times <u>greater</u> than previous estimates, and (2) the rate for proton-deuterium fusion is actually greater than that for deuterium-deuterium. Nevertheless, these rates are still so astronomically small that cold fusion, even within the confines of a palladium lattice, was quite unlikely. Koonin knew of "no way of accounting for the University of Utah results."

<u>MIT Results</u>

An "ad-hoc cold fusion group" at the Massachusetts Institute of Technology, consisting of chemists, physicists, and engineers, presented two papers at the meeting. Stanley Luckhardt reported that the MIT team, using calibrated calorimetry and gamma-ray and neutron detectors, found no evidence for excess heat or for radiation above the natural background. Richard Petrasso discussed MIT's examination of the reported neutron emissions from the Utah experiment. Such neutrons, coming from fusion reactions, would combine with protons and create gamma rays with an energy of 2.22 MeV. Trying to simulate the Utah measurements, the MIT scientists recorded a gamma-ray energy spectrum and arrived at these three conclusions: (1) the peak in the Utah gamma energy plot is narrower than it should have been (considering the inherent resolution of the apparatus); (2) the spectrum was missing an important bump corresponding to the scattering of the gamma rays in the detector; and (3) the rate of neutron production calculated by Pons and Fleischmann from their gamma data was too large by a factor of 40.

<u>Brigham Young Results</u>

Steven Jones of Brigham Young University (BYU) reported that new measurements of reactions in an electrolytic cell were consistent with his earlier observations (<u>Nature</u> Vol. 338, page 737, 27 April, 1989) of neutrons from cold fusion reactions, albeit at a rate many orders of magnitude less than for the University of Utah. Jones mentioned that his group had been collaborating with scientists at the University of Bolognia at the Gran Sasso laboratory in Italy and that they had submitted an article for publication which should appear in a few months. Steven Jones did not report any significant heat generated in his electrolytic cell.

Other Results

Scientists from several other labs, including the Lawrence Berkeley Laboratory, Yale University, Brookhaven National Laboratory, Ohio State University, Rochester University, and Oak Ridge National Laboratory, failed to find evidence for the level of neutron production claimed by the University of Utah. The Oak Ridge (J. Kirk Dickens) and possibly the Caltech experiments, whose neutron detectors operate at a sensitivity at or slightly better than, the BYU detector, seem to rule out neutron production even at the rate claimed by BYU. Moshe Gai of Yale reported that the Yale/Brookhaven neutron detector is more sensitive still: his group observed no neutrons above background down to a level some 40-100 times lower than BYU. Gai believes that Jones' neutrons may be produced by cosmic-ray showers.

Walter Meyerhof of Stanford University presented a theoretical analysis of the experiment performed at Stanford by Robert Huggins, who claims to have seen an unexplained excess of heat in an electrolytic cell. Meyerhof calculated that there should not have been any such heat and partly attributes Huggins' result to a fâilure to stir the electrolytic solution.

Two groups from the Comision Nacional de Energia Atomica in Argentina reported conflicting results. One group (J.R. Granada et al.) reported positive observations of cold fusion reactions, while another group (D. Abriola et al.) reported negative results.

Experiments Abroad

Douglas R. O. Morrison of the CERN laboratory in Geneva, Switzerland is the keeper of an informal cold fusion newsletter transmitted via electronic mail. At the Baltimore meeting he summarized results from around the world. Morrison claims to see a "regionalization" of findings: most groups in Western Europe - such as West Germany, France, and England (including the Harwell Laboratory where Martin Fleischmann is a consultant) - see no evidence to date for cold fusion, whereas support can be found in many reports from Eastern Europe. Scientists in Italy, Asia, and most of South America found positive results, Morrison said.

Morrison referred to himself as a specialist in "pathological science" or "wrong-result science." Comparing cold-fusion research to other spectacular (but short-lived) discoveries, such as "polywater," Morrison outlined what he perceived as a three-step chronology: (1) a striking result is announced and several confirmation experiments quickly appear; (2) gradually the positive experiments are balanced by an equal number of negative experiments; (3) finally an avalanche of negative reports appear.

Conclusions

It remains to be seen whether cold fusion research will conform to Douglas Morrison's pattern. APS President James Krumhansl claimed that whether or not cold fusion is vindicated, or proved to be spurious, the rapid movement of scientists into this controversial but potentially-important field was indicative of the health and flexibility of science. In addition, this multidisciplinary nature of this research seems to have brought chemists and physicists together as colleagues at many institutions. In the end the scientific method, including the need for reproducibility, will determine the future fate of the Pons-Fleischmann claim of cold fusion.

SUPERNOVA PULSAR

On January 18, 1989 scientists at the Cerro Tololo Observatory in Chile detected what seemed to be an optical pulsar with a period of half a millisecond at the location of supernova 1987A. Although many astronomers expect that a pulsar (a rotating neutron star) does lurk at the heart of 1987A, this observation was puzzling for three reasons: (1) new-born pulsars were thought to have longer periods, such as 0.1 seconds; (2) the pulsar's apparent magnetic field is less than 10^9 gauss, whereas young pulsars are observed to have fields in the range 10^{11} to 10^{13} gauss; (3) the pulsar's radiation varies in ways which imply the existence of a nearby Jupiter-sized companion at a distance of only 10^6 km.

At the Baltimore meeting, Saul Perlmutter of Lawrence Berkeley Laboratory, reported that after 12 1-hour observations made since their original January sighting, he and his collaborators had seen no new evidence for the pulsar. However, Perlmutter and several of the astrophysicists presenting theoretical papers at a special session devoted to this subject did not take the lack of follow-up observations to mean that the original indication was spurious.

Stanford Woosley of the University of California at Santa Cruz addressed the rapid-rotation-rate problem. He believes that the pulsar "spun up" by accreting mass (and angular momentum) from matter nearby, in this case matter from the supernova ejecta, in the hours following the supernova explosion. He referred to the pulsar as the fastest-rotating object and also the densest visible object in the universe. He said the pulsar was just short of being a black hole. As for why the object has apparently stopped radiating, Woosley believes that the dynamical mechanism for producing the optical beams is basically inefficient. Others