The scientific revolution implied in 'cold' fusion

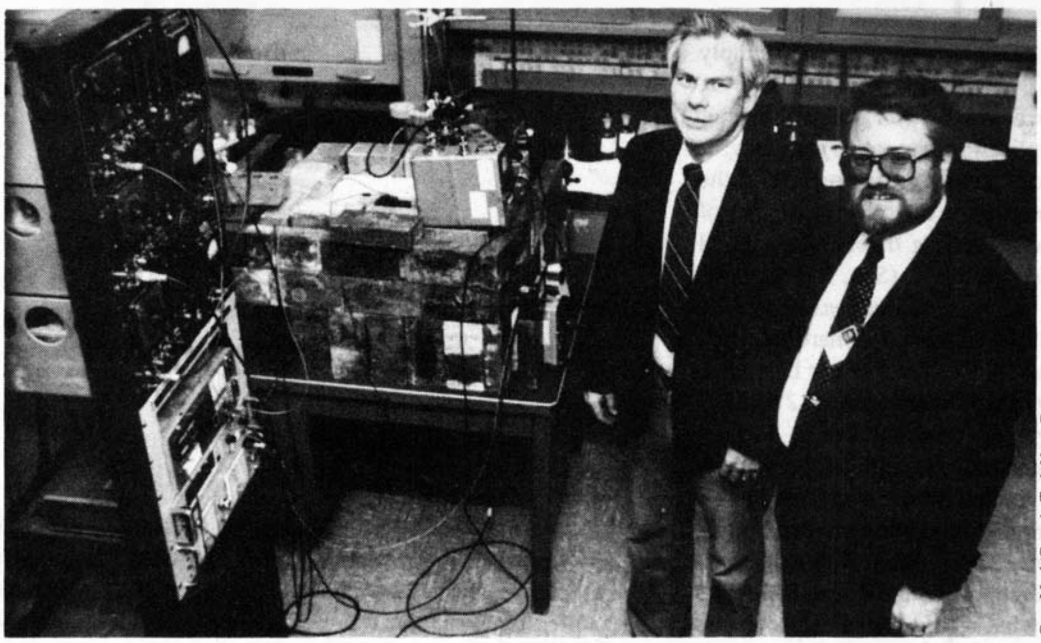
by Ralf Schauerhammer

Since the London *Financial Times* and the *Wall Street Journal* reported March 23 on the amazing results of experiments done by the ingenious electrochemists Prof. Martin Fleischmann of Southampton University, U.K. and his former student, Prof. Stanley Pons of the University of Utah, the world scientific community has been in an excited state of an order incomparably higher than that of any nucleus in Fleischmann's experiment. Beyond the concrete attempts to verify the results taking place in all important research centers of the world, the results of these "cold" fusion experiments have already stimulated far-reaching conceptual work in physics. The time seems to be ripe for basic new ideas.

Even far beyond the scientific community, the possible technological implications of these experiments are transmitting shock waves. In particular, fanatic zero-growthers, like the professional imbecile Jeremy Rifkin, are screaming that the results would be "the worst thing that could happen to our planet!" Stanford biologist Paul Ehrlich went on record with the statement that "the prospect of cheap, inexhaustible power from fusion is like giving a machine gun to an idiot child."

The potential technological revolution implied in these "cold" fusion experiments is vast. It is, however, harder to evaluate than the discovery of nuclear fission a half-century ago, because the discovery of a cold fusion process implies more subtle and far-reaching reevaluations of existing physical theory than most scientists are prepared to admit. To appreciate this, remember that within the last few years, we have already experienced two great surprises in solid-body physics which also attacked the prevailing concepts of how the microscopic realm might possibly express itself on a macroscopic level.

The first was the experimental discovery of quasi-crystals five years ago, by D. Shechtmann and I.A. Blech, a phenomenon which still awaits a solid theoretical explanation. The second was the spectacular discovery of high-temperature superconductors by Georg Bednorz and Alexander Mueller two years ago, which de-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Scientists worldwide have sought to replicate the Fleischmann-Pons experiments (see chronology, page 18). Shown here are Dr. Bill Livesay (left) and Dr. James Mahaffey of Georgia Tech Research Institute, with their cold fusion apparatus.

moted the Bardeen-Cooper-Schrieffer theory from its position as "queen of solid-body physics theory" in the eyes of physicists, to "a theory that was never of great value anyway."

So one is tempted to ask, what will be the "royal" fate of quantum theory when all the implications of the new experiments are evaluated? At the moment this question is generally not posed. But most likely it will be soon, since the situation is well characterized by the fact that chemists, on the one hand, insist that the effects Fleischmann and Pons observed cannot be thought of as "chemical," and therefore must be "nuclear"; while on the other hand, nuclear physicists claim that the effects cannot be "nuclear" at all, and therefore must be "chemical."

The main aspects of these experiments that explain the mutual exclusion of the phenomena from both chemistry and physics, are the following. What Fleischmann and Pons have done seems to be a very simple experiment. They have filled a small electrolytic vessel with heavy water, through which an electrical current of about 1 watt flows from an anode made out of platinium to a cathode of palladium. In this way, the heavy water is electrolytically decomposed and the deuterium atoms are absorbed by the palladium cathode. What they measured was first, an amount of heat in excess of 4 megajoules per cubic centimeter is generated, which cannot be explained by any chemical reaction possibly going on in the experiment, and second, tritium, helium-3, neutrons, and gamma rays, which indicates that a nuclear reaction is taking place.

If, however, one compares the amount of neutrons emitted from the experiment, with the values one would expect from known nuclear fusion reactions of deuterium for the amount of thermal energy released, the neutron flow is by more than a trillion times too low. Or, in other words, if the thermal energy measured in the Fleischmann-Pons experiment had originated from a known fusion reaction, one would expect a neutron flow coming out of their device that would have been so strong, that it would have most likely killed both researchers.

'Hitherto unknown nuclear process'

The conclusion the two lively scientists draw is straightforward: Since there is too much energy released for it to be a chemical reaction, it must be a nuclear reaction, and since it cannot be one of the known nuclear reactions, it must be a kind of nuclear reaction which is not yet known. In their article in the *Journal of Electroanalytical Chemistry,* they state, "The most surprising feature of our results, is that . . . the bulk of the energy released is due to an hitherto unknown nuclear process (presumably due to clusters of deuterons)"!

If one follows this straightforward idea, an even more profound implication has to be considered, because one then has to pose the question: What specifically does the lattice of the palladium crystal do to "catalyze," as it were, this nuclear reaction? According to orthodox physical theory, it is hard to imagine how the crystal lattice organized by the electron shells of the palladium nuclei (i.e., on energy levels of electron volts) is able to effect the fusing of deuterium nuclei in such a way that they can overcome the potential of their coulomb barrier, a process requiring an energy level of about 1,000 electron volts.

Most scientists are assuming that an explanation using the concept of the tunnel-effect would not be sufficient, and ideas about a "window in the Coulomb field" in the form of a "saddle point in the electrical field," i.e., negative curvature, are being discussed. Bearing in mind the experiments of Fleischmann and Pons, some scientists are looking at the nucleus and wondering, "It might be that it is not so simple;

probably the electrical field around the nucleus is not simply spherical."

This geometrical argument is, however, quite heretical, if all its epistemological implications are taken seriously. It leads back to the question of a geometrical structure of the nucleus, which was still immanent in the scientific debate of 1949-50, shortly before the prevailing theory of the shell structure of the nucleus was developed. (See, for example, the papers concerning this in *Die Naturwissenschaften* by Erich Bagge, Otto Haxel, J.H.D. Jensen, Richard Lepsius, and Hans Eduard Suess; and "A Nuclear Pioneer Discusses the Geometric Nucleus," by Ralf Schauerhammer, *21st Century Science and Technology,* Nov.-Dec. 1988).

The introduction of geometrical concepts of the nucleus even have implications for the notion of relativistic space-time and the stochastic interpretation of the uncertainty principle of quantum mechanics. These implications of again giving value to geometrical or topological concepts in nuclear physics are comparable to what would happen to someone who believed he was rolling a little ball (a little Coulomb sphere) over a table top, and tried to explain statistically why it comes to rest in certain "quantized" states, who now realizes that, in fact, he has been throwing dice (actually very many at the same time have to be thrown). Recognizing the ontological importance of geometry will thus lead to a reevaluation of the epistemological importance of Einstein's famous motto: "God does not play dice." It holds out the promise, however, for the chance to derive a unified concept of the nucleus, together with its shell and its macroscopic manifestations in solid bodies and living matter as well.

A rebirth of cultural optimism

Some people will question where I find the confidence to spell out such a far-fetched hypothesis about the development of scientific thinking. It comes from the fact that even before the discovery of quasi-crystals and high-temperature superconductors, I was convinced that if quantum theory tried to extend itself into the realm of coherent many-body problems of solid-body physics, we would witness just such mind-boggling results as are now being reported. Instead of waiting for further surprises, I would propose a research program, which assembles and evaluates anomalies in different areas of physics, astrophysics, chemistry, and biology from the standpoint of the primary importance of the ontology of topology.

Relating such a research program back to the question of revolutions in technology, we see the promise of much more than only the realization of "cold" fusion itself, but the generation of whole families of new technologies, similar to what happened in connection with the development of thermodynamics, electrodynamics, and nuclear physics before. Such a real scientific and technological revolution will again stir up cultural optimism and the belief in man's creative powers to overcome existing problems.

Congress grapples with fusion results

by Marsha Freeman

At a lively and well-attended hearing on developments in the new research in cold fusion, held by the House Committee on Science, Space, and Technology April 26, enthusiastic congressional support was given to the principal scientists, Martin Fleischmann and Stanley Pons, and their work. Rep. Marilyn Lloyd (D-Tenn.), a longtime supporter of fusion research and chairman of the Energy Research and Development subcommittee, summed up the sense of the congressmen in opening remarks: "Energy is the lifeblood of a nation and fusion energy would be an enormous step towards the goal of energy independence. . . . Gentlemen, the world awaits the crucial details of your amazing claim."

Full committee chairman Robert Roe (D-N.J.) announced that members of the committee will travel to Utah in the near future to observe the experiment of Drs. Fleischmann and Pons. The more than two dozen congressmen present at the hearings, and over 200 observers and press, listened in rapt attention as the scientists explained their experiment using a scale-model.

Unfortunately, the genuine good will and interest of the majority of the committee members is being balanced against an irrational budget process, where, as chairman Roe explained in frustration, the science and technology programs will suffer still more cuts this year. But this means that only an *unserious* commitment will be able to be made by the federal government to support this newest of exciting developments in science and technology, unless there is a change in overall budgetary and economic policy.

Robbing Peter to pay Paul?

The problem is indicated by the announcement by ranking minority member of the committee Rep. Robert Walker (R-Pa.), that at the April 6 mark-up for the fiscal year 1990 fusion budget, Mrs. Lloyd's subcommittee reprogrammed $5 million from the magnetic fusion energy program to basic energy science, specifically earmarked for the cold fusion research effort.

While it is certainly to the credit of the congressmen that they were moved to respond so quickly to the breakthrough