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 and show their good will by allocating money, to take those funds from the paltry magnetic fusion program is a grave mistake.

For the eight years of the Reagan administration, the budget level for magnetic fusion research hovered around $350 million, meaning that the real, inflation-adjusted dollars declined by over one-third. Due to this level of contraction, experiments have been delayed, major milestones have been missed, and recently, engineers and contractors have even been laid off from laboratories.

In 1980, President Carter signed the Magnetic Fusion Energy Engineering Act, after it had been passed nearly unanimously by both houses of Congress. Had that law been implemented, energy breakeven in conventional fusion experiments would most likely have already been demonstrated, and the United States would be leading the world in fusion research, because an engineering test reactor would now be under construction. The money has never been allocated to meet these next milestones in magnetic fusion.

This year, the Bush administration has allowed the Department of Energy to request $349.2 million for magnetic fusion in FY1990—down $1.5 million from 1989.

At the end of the Carter administration, nearly all of the work in laser and other forms of inertial fusion was classified, and since then virtually all funding for commercial reactor design and technology development has been eliminated from the budget. There is no way of knowing how far laser fusion development would have progressed over the past decade, because we have kept the non-weapons program at a standstill.

Not one or the other

As stressed by Dr. Fleischmann at the hearing, it would be a mistake to think that the research in cold fusion, even were it to prove itself commercially viable, should *replace* the ongoing work in magnetic confinement fusion.

First, it may well be that there will be different and unique applications for each type of fusion. For example, if indeed the cold fusion process yields almost entirely heat, without the highly energetic neutrons and other high-temperature fusion products, this might be an ideal heat source for small-scale applications, particularly in developing nations which have no central energy distribution infrastructure, as Dr. Fleischmann pointed out.

Third World countries might be the major market for cold fusion machines to produce electricity as well, while the industrialized nations would use the larger, baseload electrical power devices developed from high-temperature fusion.

In addition, it is clear that the materials research, leading edge diagnostic devices, energy conversion and power conditioning technology, and overall engineering and subsystem equipment development that have been part of the magnetic fusion research for many years, will be invaluable for cold fusion research and development.

Cooperation, not competition for dwindling funds, among the Utah scientists, the national energy laboratories, and other universities will produce the quickest progress in this exciting new field. The national laboratories have the most sensitive, advanced, and sophisticated diagnostic capabilities in the country.

Drs. Pons and Fleischmann announced at the hearing that they have built another experimental apparatus, similar to the one they have been using, for a team of scientists from New Mexico's Los Alamos National Scientific Laboratory. This will hasten the rate of breakthroughs that will be made.

Representative Walker mentioned at the hearing that the committee would consider adding $25 million for cold fusion research later on this year. He did not mention where the money would come from.

Leaving the U.S. behind

One witness at the hearing, business consultant Ira Magaziner, stressed that if the United States does not support this research, and also make it possible for industry to develop commercial products to bring to the marketplace, cold fusion will follow a long list of other basic scientific advances which were produced here, but commercialized by other nations.

According to Magaziner, "A recent Office of Technology Assessment study team concluded that the Japanese were already ahead in commercializing products" from high-temperature superconductivity. He remarked that since the superconductivity development, "in Japan, billions are being spent through the agency for Industrial Science and Technology located within the Ministry of International Trade and Industry on dozens of joint projects bringing together companies, government laboratories, and universities to pioneer products for the 1990s."

By contrast, in the United States, "a few hundred million [dollars have been] funneled through the Defense Department for a handful of projects." The lack of U.S. government help in transferring technology from the laboratory to the marketplace, Magaziner stated, stems from "bizarre" and "soul-wrenching debates about whether we are violating our free-market principles."

What Magaziner did not state, but is the case, is that the Japanese are simply directing their advanced technology development using the American System economics of investment in science, industry, and infrastructure to further overall economic growth. This policy approach is what made the Apollo Program not only the most uplifting moment in this century's history, but the economic driver for more than two decades of technological innovation.

Low-interest credit for industrial investment, tax credits for the construction of new manufacturing facilities, investment in R&D, and financial penalties for spending on waste like junk bonds and leveraged buy-outs: That is how to reverse American technological stagnation.