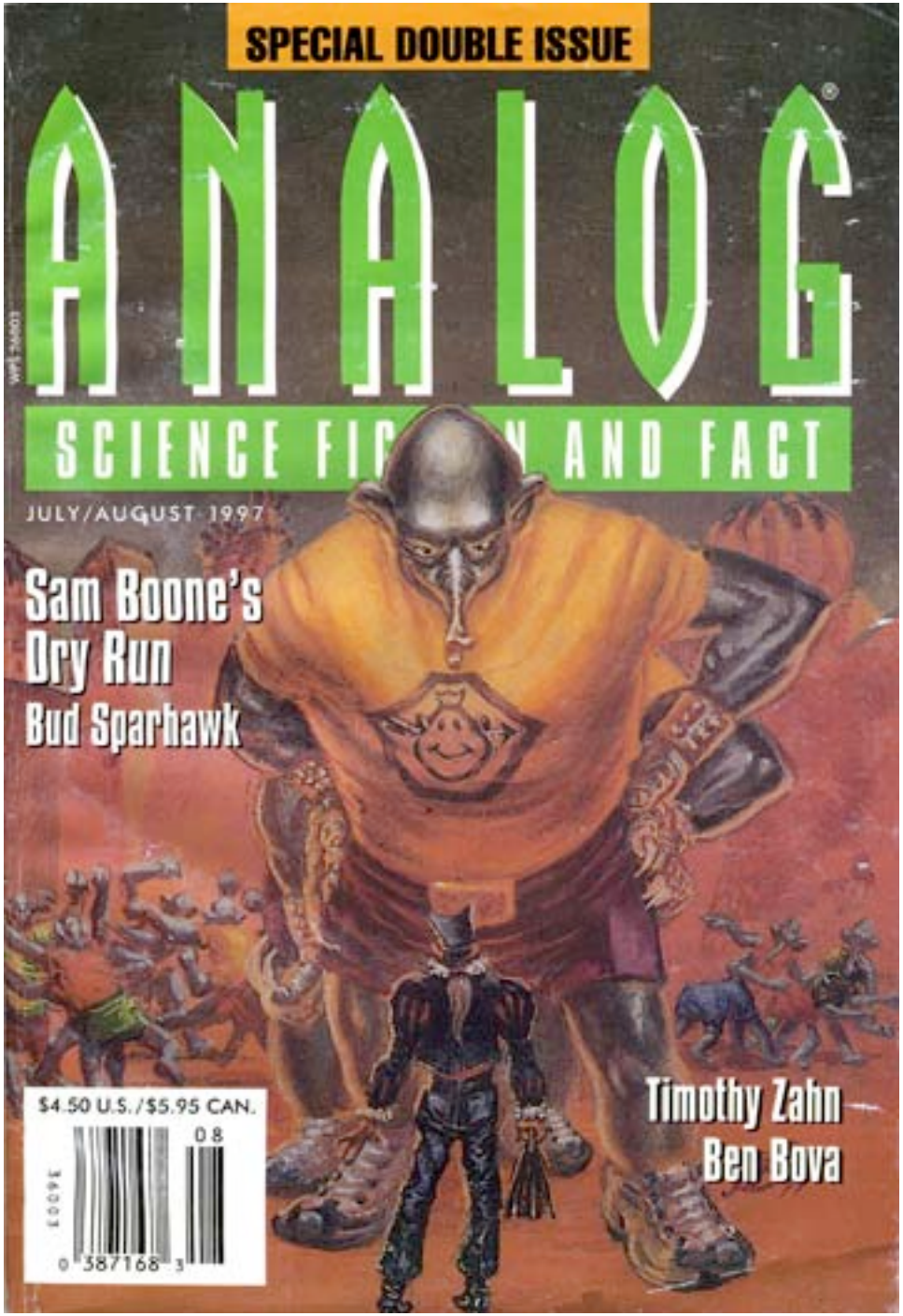


Dr. Eugene F. Mallove

# COLD FUSION: THE "MIRACLE" IS NO MISTAKE

*It's simply not true that "nobody's doing cold fusion research any more" or even that "nobody's getting results." Here's a summary of what's been happening, and a chance to check it out for yourself.*

There is something very new under the Sun. The worst nightmare of the aging nuclear physics establishment has come true: there is far, far more to nuclear reactions than "was ever dreamt in its philosophy." The class of heretical, near room-temperature nuclear phenomena, dubbed "cold fusion" since the flamboyant Utah announcement of March 1989, are now confirmed and are beginning to be commercialized. The acid test for any revolutionary discovery—entry to the marketplace—is happening right now for cold fusion, whether or not the critics

agree. It is now possible to acquire for research purposes a low-power, radiationless, tabletop nuclear reactor for less than $4,000!

The much-maligned press conference by Drs. Martin Fleischmann and Stanley Pons at the University of Utah, on the afternoon of March 23, 1989, occurred, fittingly, less than twelve hours before the Exxon *Valdez* ran aground off the coast of Alaska. Fleischmann and Pons, for those few who don't recall, claimed that they were getting excess thermal energy far beyond electrical input energy from an electrochemical cell with a palladium cathode and a heavy water electrolyte. The cell output, they said, was substantially more than could be explained by any chemical reactions.

Provocatively, they suggested the phenomenon had to be nuclear and they posed some then very weak evidence for nuclear reaction products. Problematic as this initial *nuclear* evidence turned out to be—tritium and neutrons, experiments by others were later to confirm very low level neutrons but utterly unambiguous radioactive tritium, as well as other nuclear changes. If anything, Pons and Fleischmann were too conservative. They had really glimpsed a whole new world of solid-state nuclear reactions. Their press conference, which triggered the present worldwide cold fusion quest, will eventually live not in scientific infamy, as many still imagine, but as the beginning of the end of the Fossil Fuel Age and the birth of new physics.

As for the multi-billion dollar, half-century *hot* fusion effort, whose leaders ran scared after the cold fusion announcement, the end of the road is near. The tokamak reactor Sun-worshippers of Princeton and MIT should start planning new careers, or begin to take cold fusion seriously—as at least *some* hot fusion researchers at labs in Japan, the US, and Russia already have. Hot fusion has never produced a single watt of excess energy, and if it ever does it would be in the form of lethal radiation. Cold fusion, whose primary signature is excess heat with no deadly radiation, exceeded breakeven at birth—in 1989. For budgetary reasons, magnetic confinement hot fusion funding in the US has recently been cut drastically by the Congress. In a few years, this once heroic, now irrelevant white elephant will expire, as scaled-up cold fusion devices penetrate the marketplace. The implications of the astonishing cold fusion discovery will finally sink in. Already, former chairman of the House Science Committee, Robert Walker (R-PA), has publicly acknowledged the reality, importance, and mystery of cold fusion.

Many other "establishments"—including the planet's entire fossil fuel and fission power infrastructure—are also in for rude awakenings. Even hydropower, solar, and windmill energy, which may still have their place in the coming New Energy Age, will be marginalized. It will be extremely difficult, even for contemporary "sustainable energy," to compete with compact, environmentally benign power systems that do not bow to Earth's rotation or the vagaries of weather. The



electric power grid will wither away as consumers increasingly adopt self-contained domestic power units based on cold fusion, or "new hydrogen energy," as the Japanese official program calls it. Air pollution will plummet and the threat of global warming will dissipate.

It must be said that "cold fusion" is merely convenient historical nomenclature for a class of thermal and nuclear phenomena, not a definitive microphysical explanation as nuclear fusion per se, though fusion aspects are almost certainly involved. The *mechanisms* of cold fusion are indeed still being hotly debated by theorists; no single theory appears to have an edge. The experimental data that need to be explained are still very difficult to put under one umbrella—rather like trying to explain all of chemistry with a single model in 1870!

### *Paradigm Paralysis*

How can it be that eight years after cold fusion's advent, one of the greatest discoveries of all time is being largely ignored or ridiculed by the general media? How has it happened that looming cheap, safe, and abundant energy from water and inexpensive metals like nickel has been pushed aside in favor of media fixation with the likes of O.J. Simpson or Saddam Hussein? Easy. The paradigm-fixed minds of even some otherwise brilliant scientists recoil from the notion that *They* Have Missed Something Very Big; thus they are adamant: "Cold fusion is nonsense!" Regrettably, for pack-mentality journalists these are the only opinions that matter. A few science journalists have followed the story moderately well, but their voices are lost in the silence of the lambs. Not surprisingly, the same ignoring of revolutionary developments happened to heavier-than-air powered flight between 1903 and 1908, to spaceflight between 1926 and the late 1940s, to continental drift from 1912 to the early 1960s, and it will happen again to even greater paradigm shifts.

In many ways, the cold fusion "war" these last eight years bears closer resemblance to the Galileo affair of nearly four centuries ago. The Church fathers refused to look through Galileo's telescope, because they *knew* the sight through that quaint tube could not possibly contradict their understanding of the heavens. If it did *seem* to contradict their opinions, it had to be a mistaken instrument. House arrest or burning at the stake are not the instruments of oppression today, but threats to academic freedom have been severe and stifling to cold fusion investigators. The late physics Nobel laureate and eminent cold fusion theorist, Julian Schwinger, felt compelled to resign from the American Physical Society because of its abuse of the publication process. Professor Peter Hagelstein of MIT, a brilliant laser theorist and former nuclear weapons expert, was nearly denied tenure because of his pursuit of cold fusion. Distinguished Professor John O'M. Bockris at Texas A& M University, one of the world's greatest electrochemists, was attacked and asked to resign by some of his colleagues because of allegations

of fraud in his cold fusion and low-energy transmutation research. Fortunately, he was fully exonerated despite this latter-day witch-hunt.

Many twentieth-century scientists react the same way to cold fusion as church officials did to the heliocentric theory: they most often refuse to look at the data. To them the "miracle" of cold fusion is a vast mistake, not a window to a new realm that transcends high-energy nuclear physics and chemistry. Abandoning the foundation of science—the primacy of experiment—they arrogantly demand an explanation of the cold fusion anomalies that fits all their preconceived notions of how nuclear reactions must occur. That there could be reactions in the solid state differing from high-energy physics is ***unthinkable*** to them: What about the seemingly impenetrable electrical repulsion Coulomb barrier between all positively charged nuclei; what about the lack of expected lethal radiation? These are mocked as the two impossible "miracles" of cold fusion. The dozens of intriguing theories that would seem to permit cold fusion reactions are rejected outright.

Noted physicist Professor Herman Feshbach of MIT angrily told me in 1991 (and essentially recapitulated on ABC television's *Nightline,* February 7, 1996, when commercial cold fusion cells were being discussed): "I have had fifty years of experience in nuclear physics and I know what's possible and what's not possible. I don't want to see any more evidence! I think it's a bunch of ***junk*** and I don't want to have anything further to do with it." In 1991 I had merely suggested that Feshbach examine the excellent review articles about the mounting cold fusion evidence, which had been done by scientists at Los Alamos National Laboratory and the Bhabha Atomic Research Center in India. It seems that it is far easier for the mainstream to believe in alleged fraud and incompetence than to accept hard data in numerous peer-reviewed cold fusion articles, data that contradict long-held tenets of nuclear physics and chemistry.

While the cold fusion triumph is astonishingly good news for the environment and the energy well-being of civilization, it is extremely bad news for business-as-usual, incremental science. Mainstream scientific publications have been loathe to recognize what has been happening these past eight years in laboratories from Los Alamos to Beijing. What *else* have they missed, laypersons will rightly ask? The US Congress should consider hearings in this "HeavyWatergate" affair, an abuse of government power and misappropriation of scientific resources that makes Whitewater and Watergate look like tempests in teapots. After all, how many citizens will have died needlessly as a result of air pollution illness, due to the years of unwarranted delay in the development of cold fusion technology?

### *The Evidence: Pro and Con*

Dozens of laboratories with multimethod cross-checking, especially by many types of heat-measuring calorimetry, have established the cold fusion findings on firm ground. However, a theoretical understanding of what these data mean—how the processes work—is not yet at hand. That will come. The only flimsy evidence *against* the reality of these phenomena, from the dark mists of 1989, now lie discredited in several technical journals. The Department of Energy's panel of 22 people who investigated cold fusion claims in 1989, came to a thoroughly unjustified, rushed judgment, less than six months after the Utah announcement. This even as positive results were pouring in from around the world in the fall of 1989 (#1). Not surprising, because several top figures on that ERAB Cold Fusion Panel are on record with statements that the cold fusion claims were "preposterous to begin with."

Furthermore, the so-called "null cold fusion experiments" of prestigious Caltech, the MIT Plasma Fusion Center, and Harwell Laboratory in the UK in 1989 were anything but null. Cooler heads looking back at their data found egregiously faulty analysis, experimental incompetence, and worse (#2-6). With remarkable chutzpah, the anti-cold fusion camp, clinging to its rushed and faulty experiments of 1989, denigrates increasingly perfected positive experiments. The goalposts keep getting moved. It is clear now that *no* cold fusion experiment, no matter how sound or well-published, will be believed by the vested academic interests. It shouldn't be this way, but it will take commercialization—products that heat homes and run cars—to silence the naysayers. As one hot fusioneer at MIT put it in 1993, "I suppose I'll believe it when they drive a car up from New Jersey."

Both the nuclear-scale energy production and nuclear products—low-energy, alchemy-like transmutation of heavy elements in cold fusion—have now been proved. The energy release observed so far from cold fusion reactions is slow (fortunately!) but spectacular: thousands to millions of times beyond any conceivable chemical reaction in those systems—tens, hundreds, and thousands of megajoules per mole of active material in the cells, for those who understand those terms. Moreover, there are no chemical changes in cold fusion systems that could begin to explain the energy release—much less the nuclear reaction products found: transmuted heavy elements, helium-4, occasionally radioactive tritium, and an extremely faint neutron emission (the latter often nonexistent or very near ambient background level).

To be sure, these are provocative conclusions about one of the most reviled, disputed anomalies in the history of science. The opponents say it is all "pathological science," like N-rays or polywater—as though stereotyping with a name can explain away replicated data gathered by some of the finest laboratories in the world. In truth, the data from the best cold fusion experiments are now all but unarguable, except by a vociferous band of professional "pathological skeptics."

In May 1991, when I completed my account of the cold fusion quest to that point, *Fire from Ice: Searching for the Truth Behind the Cold Fusion*

*Furor* (#7), I suggested that the evidence for cold fusion phenomena was overwhelmingly compelling. I acknowledged then that there was a remote chance that it could *all* be wrong, and I was not certain that technological applications would emerge quickly. Three other books came out, which took a very hard line against cold fusion, each concluding that the affair was an example of "pathological science" (#8-10). Fortunately for our energy and scientific future, these books concluded incorrectly. They will provide historians with a fascinating view of skepticism run amok. They are each good examples of Arthur C. Clarke's observation in 1963: "It is really quite amazing by what margins competent but conservative scientists and engineers can miss the mark, when they start with the preconceived idea that what they are investigating is impossible. When this happens, the most well-informed men become blinded by their prejudices and are unable to see what lies directly ahead of them" (#11).

Each year since 1991, the evidence for cold fusion has grown more convincing. There are literally thousands of papers now documenting cold fusion phenomena. There were only hundreds in 1991. In the space of a short article it would be impossible to do justice to this large body of literature, but the reader may wish to look into the various international meeting proceedings, compendia, and selected papers referenced below (#12-77). And for those who really see the light and have a burning curiosity about what they have missed, *do* make arrangements early for the Seventh International Conference on Cold Fusion (ICCF-7), which will be held in Vancouver, Canada from April 18-23, 1998. The most recent one (ICCF-6) was held October 1996 in Hokkaido, Japan, not far from Sapporo, where Japan's MITI has set up its "New Hydrogen Energy" (cold fusion) laboratory to coordinate the large but conservative Japanese program.

Japan is even funding work at SRI International in California, previously supported by the research arm of the US private utility consortium, the Electric Power Research Institute (EPRI). The EPRI final report on its $10 million cold fusion research states: "This work confirms the claims of Fleischmann, Pons, and Hawkins of the production of excess heat in deuterium loaded palladium cathodes at levels too large for chemical transformation. . . . Further, the excess energy exceeds that of known chemical processes by two or more orders of magnitude." (#44) It is noteworthy that the EPRI cold fusion program continued, despite the tragic cold fusion cell explosion at SRI that killed electrochemist Dr. Andrew Riley in January 1993.

Drs. Fleischmann and Pons have been vindicated by EPRI, but in other ways too. Leaving the hostility of the US scientific establishment behind, in 1991 they were set up near Nice, France, by a member of the Toyota dynasty, the late Minoru Toyoda. At the IMRA Europe laboratory today, the Icarus-9 calorimeter has produced months of continuous data from cells at boiling temperature, exhibiting thermal output of twice the input electrical power—all from a tiny palladium cathode. Recently, Dr. Fleischmann has retired to his home in England, but the work in France goes on. In fact, one of the top members of the French Atomic Energy Agency performed a replication of the Fleischmann and Pons calorimetry of a few years ago (#34) and at ICCF-6 pronounced it sound. The European Patent Office has given notice to US-based cold fusion company ENECO of Salt Lake City that the Pons and Fleischmann patent will be approved. Not so in the US, as the war rages in Washington against cold fusion. The Department of Energy continues massive funding for various hot fusion programs and fission power research, but not one cent has been allocated for cold fusion. Any research on cold fusion at national labs has been either "bootlegged" under duress, or paid for out of "director's discretionary funding."

### *The Patterson Power Cell™ and Beyond*

Though the case for a spectacular new class of phenomena connected with special conditions of hydrogen isotopes in contact with metals and other materials is surely proved, we don't know which of the few dozen or so theories best explains the expanding category of anomalous nuclear and nuclear-like phenomena. Dr. Storms calls these "chemically assisted nuclear reactions." An outstanding example, but by no means the only one, of how certainty has built up and how commercialization is occurring despite the lack of agreed-upon theory: Clean Energy Technologies, Inc. (CETI) of Dallas, at a meeting of the American Nuclear Society in Washington DC in the fall of 1996, announced the marketing of a Research Kit based on the patented Patterson Power Cell (#63).

Dr. James Patterson, a former polymer chemist with Dow, is lucky to hold the first of a series of US patents on his cold fusion device, which resembles the Fleischmann-Pons cell, but uses metal film-coated beads as electrodes, rather than bulk metal ones. The patent was granted by another division within the USPTO that had not been privy to the rejection of hundreds of other patent applications for cold fusion by the other USPTO branch. The latter summarily rejects everything connected with excess energy or "nuclear reactions in the cold," often citing news clips by journalists from 1989 as well as now discredited "null" experiments from that era.

At the November 1996 meeting in Washington, Patterson and his colleagues demonstrated his cell's robust excess power production, but the main purpose of the kit is to demonstrate definitive, safe nuclear reactions near room temperature. The kit can be rented for a year for $3,750 and purports to be able to show the numerous transmuted heavy elements in the metal-coated beads of the cathode. Nuclear engineering professor George Miley of the University of Illinois has documented the transmutations occurring in the thin layer of metals coating the beads of this type of cell (#80).

Though the power output of the Patterson Power Cell varies from cell

to cell, in one instance of operation at the large PowerGen '95 energy meeting in Anaheim, California, my colleague Jed Rothwell measured a thermal power output of 1,300 watts for an input electrolysis power of only 1.4 watts (#67 ). That was a powerful cell, but the reactive zone of Patterson beads was only 40 cubic centimeters. More commonly, Patterson cells put out 5 to 10 watts with an output/input power ratio from 3/1 to 30/1. The PowerGen '95 device heated the hotel suite so much that the locked air-conditioning controls had to be reset by hotel staff! Skeptics still do not believe this type of experiment. It *is* pretty unbelievable, yet it is real.

Perhaps skeptics will believe this experiment that was conducted by the Motorola Corporation on a Patterson cell. These data were shown by Dr. Cravens, a consultant to CETI, at a meeting in Denver in 1996: after the Patterson cell was initiated by being heated to the proper temperature (65°C), the input power was turned off. There was *zero* electricity going in. The cell continued to put out 20 watts of thermal power as measured by a delta-T across the cell of 15.1°C, at a flow rate of 20 milliliters per minute of water electrolyte. This episode lasted for some 11 hours in the data shown, but Cravens said that the heat-producing reaction took a few days more to peter out! When was the last time you saw an object being cooled by water stay hot as a 20-watt light bulb for days? Case closed. This is the so-called "heat-after-death" phenomenon observed by other workers in the field, notably Pons and Fleischmann, as reported in a 1993 *Physics Letters A* paper (#34). The Patterson Power Cell of CETI has recently made national television news; it was covered on ABC television's *Nightline* and *Good Morning America* on February 7, 1996.

The cold fusion field has brought many surprises like the Patterson Power Cell, the most astonishing of which was finding excess energy and nuclear effects in systems radically different from that of the original Pons and Fleischmann heavy water and palladium electrolysis. The first major shock was the revelation in mid-1991 by Randell Mills and others (#51) of massive excess heat production in ordinary water cells using nickel cathodes and potassium carbonate electrolyte. NASA tests have confirmed this excess heat production. The Patterson cell also is based on ordinary water, which, of course, contains a tiny amount of heavy water, so it is still not clear what the critical fuel is.

Mills and his colleagues at HydroCatalysis Power Corporation in Malvern, Pennsylvania, are known to have abandoned their original electrolytic approach in favor of hydrogen gas-fueled cells using proprietary nickel catalysts. These cells produce extremely high temperatures, which Mills suggests comes from his "hydrino mechanism"—the catalytic shrinking of the hydrogen atom below the normally understood ground state. Mills distances himself from the mainstream cold fusion community, because he does not agree with the interpretation of the nuclear evidence.



Yet HydroCatalysis is actively engaged in development that could lead to a one-kilowatt electric generator within the next few years. Theory aside, his company might well be in the lead toward the goal of commercial electrical power generation, but there is competition. Piantelli's group in Italy (#35, 36), supported by Fiat Corporation, likewise has confirmed non-chemical power generation in high-temperature gas-phase cold fusion systems. Dufour in France has found excess power in hydrogen gas-metal cells employing mild electrical discharge (#91).

T. Mizuno's group in Japan and Professor Richard Oriani at the University of Minnesota have pioneered "solid electrolyte" ceramic proton conductors, which operate at hundreds of degrees centigrade and appear to have demonstrated power ratios of up to 70,000 to 1! (#54, 61) Though spectacular in performance and confirmed by several types of calorimetry, the proton conductors have not been especially reliable. If they could be made to work consistently, they might become the most prominent method in the field.

Professor Arata in Japan, one of the key pioneers in that country's hot fusion effort, is now firmly in the cold fusion camp. He has mastered a "double-cathode" technique using palladium, in which prodigious quantities of energy and corresponding helium-4 production has been observed (#18, 19). He doesn't hesitate to call this cold fusion. In fact, at the recent ICCF-6 in Hokkaido, there were at least five groups reporting evidence of helium-4 production in cold fusion cells—one of the goalposts that was long ago moved off the map by the skeptics.

The tritium evidence was the clincher for my firm acceptance of cold fusion in 1991. Since 1989, dozens of cold fusion experimenters have seen it. This tritium is *cold;* that is, it does not emerge with corresponding high-energy neutrons that would be expected if it were created in the standard hot fusion reaction. Since tritium has a half-life of 12.5 years, it can't easily have been in the systems as contamination. Besides, such contamination was rigorously checked for. The final report of the politically ill-fated Utah National Cold Fusion Institute (1991) contains clear descriptions of *reproducible* tritium generation in experiments by the ultra-cautious electrochemist Dr. Fritz Will (who was then less convinced about the nuclear explanation for excess heat). These have been published in the *Journal of Electroanalytical Chemistry* (#76, 77). Tritium has been reproducibly generated in gas-phase cold fusion cells by the Claytor group at Los Alamos National Laboratory. This work parallels Russian experiments that also get reproducible, cold tritium.

Perhaps most astonishing of all is the observation of radioactivity *reduction* in cold fusion systems! As this article went to press, CETI announced it had been awarded a US patent on an electrolytic process for reducing the radioactivity of thorium and uranium. Patterson's group has found that radioactive materials placed in a special

matrix are reduced by over 90% in periods less than 24 hours—compressing into hours what nature takes billions of years to do. There are at least three other groups who also claim to be able to do this, by other methods which have yet to be awarded patents. The path is now wide open to clean up the radioactive waste produced by the moribund fission industry and the nuclear weapons enterprise—both here and abroad.

### *The Tip of an Iceberg?*

To those who have not followed the field, the conclusion that an energy and new physics revolution is at hand may seem rash. However, the evidence for the anomaly of excess energy production at levels that cannot be explained by chemical reactions has not gone away. Instead, it has appeared in an increasing variety of different chemical and physical systems. I know of no physical effect with even a hint of commercial potential and social benefit that was not eventually scaled up and commercialized. Look what has become of the flimsy transistors of the late 1940s, not to mention the weak, originally disparaged electric light bulb of Edison in 1879!

Nor have the numerous by-products of nuclear reactions occurring near room temperature gone away: heretofore these were thought to be totally impossible. With each passing month these lines of evidence get stronger and stronger as they are revealed with a multiplicity of experimental techniques. These impressive results are increasingly appearing in peer-reviewed journals, such as *Physics Letters A*, the *Journal of Electroanalytical Chemistry*, the *Japanese Journal of Applied Physics*, and *Fusion Technology*, to cite but a few examples.

It is abundantly clear now that the widely denied discovery of Fleischmann and Pons was but the "tip of an iceberg," in which the boundary between chemistry and nuclear physics will be demolished forever. "Cold fusion" may or may not be literally the "fusion" of hydrogen isotopes at room temperature, although some theorists at the US Naval Research Laboratory, Drs. Scott and Talbott Chubb, still think it is. Whatever the detailed microphysical explanation turns out to be, it will, in part, involve nuclear reactions. It will also have to incorporate the release of macroscopic energy at prodigious levels that are *consistent* with nearly radiationless nuclear reactions.

You may think that alchemy has risen from the grave. It has. The transmutation of heavy elements in presumptively "chemical" systems has been prominently observed in a variety of cold fusion experiments (#23, 24, 78-81). In recent years, the evidence for nuclear transmutations of a variety of cold fusion experiments continues to pile up. The CETI cell is, in effect, the world's first commercially available transmutation device. Open any of the recent issues of *Infinite Energy* Magazine, and you will find technical papers by researchers in the US and in Japan that document these transmutations. Isotope distribution shifts have been seen in existing electrode elements and the creation of new elements with highly non-natural isotope abundance ratios has been observed. The latter evidence rules out the possibility of any type of preexisting contamination to explain away the transmutation evidence.

Physicist Dr. Kevin Wolf at Texas A&M University, who has been highly skeptical of cold fusion, nonetheless performed a Fleischmann-Pons-type experiment in 1992 and serendipitously discovered unambiguous gamma ray evidence of no less than seven radioactive isotopes that were formed in his palladium cathodes—isotopes of rhodium, silver, and ruthenium. (In 1993 and 1994 this researcher chose not to publish his results, so as not to be ridiculed by his physicist colleagues.) With the tacit approval of an administrator at EPRI, we published the Wolf results in *Infinite Energy* (#82). The implications for other areas of science of the transmutations phenomenon, for astrophysics, chemistry, geology, and possibly even biology, may very well be profound.

Do we know for certain that the nuclear "ash" that has been found in cold fusion experiments actually explains the associated energy releases? The answer is a qualified *no*. The existing "cold fusion dogma"—if there can be any such thing as "dogma" in so heretical a field as cold fusion—is that the ash will be found to add up to be commensurate with the thermal energy releases, in the sense that the mass loss by the identified reactions will translate in an $E=mc^2$ sense to the liberated energy. However, others have speculated that the existing ash is merely the auxiliary evidence of something even more profound: the tapping of Zero Point Energy (ZPE)—quantum vacuum fluctuations, or space energy. Certainly, at least a few excellent papers show that, in principle, there would be no violation of the conservation of energy from the tapping of ZPE (#85, 86). The answer to whether cold fusion is "merely" a whole new class of benign, nearly radiationless nuclear reactions, or whether it is an even a more potent energy source such as ZPE, will emerge in the coming years.

Apart from its revolutionary technological applications here on Earth, if cold fusion is "just" benign nuclear reactions, we will soon own the Solar System, figuratively speaking; if it is ZPE-tapping, we will own the stars! I predict that cold fusion technologies will revolutionize spaceflight, almost overnight, as soon as the reactions are tamed in small, commercially available reactors. We will have not only cold fusion-driven electric power modules for satellites, space stations, and deep space probes powered by ion engines, but also perhaps high-thrust-to-weight rockets that can launch safely and cleanly from the Earth's surface. Cold fusion is cold by multi-million degree hot fusion standards, but some effects seen already are really hot—not so "cold" as to preclude high-thrust air-breathing or rocket engines.

There are even a few well-documented other claimants that may be part of the cold fusion "iceberg." Cold fusion has inspired others to take a look at water cavitation devices such as the Hydrosonic Pump™ of Hydro-Dynamics, Inc. of Rome, Georgia, which we find is almost certainly

"over-unity" in energy production at the multi-kilowatt level. I and my colleague Jed Rothwell have performed our own measurements on this steam or hot water-producing apparatus and find it substantially over-unity—from 10 to 30% more thermal energy out than electric power input to drive the system's electric motor. Other engineering investigators have found the same results. The collapsing cavitation bubbles within the hydrodynamically shocked, thin water annulus of this device may have something to do with how excess power is being produced. Perhaps the effect is connected with *sonoluminescence*, the light from such cavitating bubbles, which Eberlein (#86) explains as ZPE-tapping? These devices are already being sold for their numerous environmental benefits, whether or not their over-unity effect is real.

Finally, we cannot fail to note the Pulsed Abnormal Glow Discharge (PAGD) reactor of Drs. Paulo and Alexandra Correa, of Labofex in Concord, Ontario, Canada (#88-90). This patented vacuum tube electrical discharge device self-oscillates in an unusual electrical glow discharge regime, which was apparently overlooked by earlier observers this century. Its performance is extremely well-documented in United States patents. Driven by an input battery pack, it charges up an output battery pack. These input/output packs have been interchanged in runs lasting many hours and it is found that *both* packs have higher charge states when the process is over. There is no electrolytic "fuel" conceivable to explain this phenomenon. The tubes are fashioned of glass with aluminum electrodes and ordinary gases. Moreover, the inventors are behaving as good scientists, not like some paranoid folk who have made similar claims without extensive documentation. If this device is real—and it *does* seem to check out so far—all bets are obviously off about the future course of physics and civilization.

### *Any Fallout?*

The technological and social implications of "cold fusion" are as astonishing as the scientific ones. It means nothing less than the end of the Fossil Fuel Age, the demise of fission nuclear power, and the beginning of a water-fueled—a hydrogen isotope-fueled—civilization. Energy will be cheap and environmentally benign. The fuel reserves (if there really is any atomic *fuel* [except ZPE] at all) are effectively infinite and available to all nations. Moreover, prototype cold fusion systems that can heat homes and produce electricity are emerging right now. The time scale for development is uncertain, however. Development and research funding has been extremely difficult to come by. The most bold venture capitalists seem to freeze when contemplating potentially trillion-dollar enterprises. A bit "too big for their plates" may be the problem! Still, it seems likely that in the next few years kilowatt-level reactors producing heat—and perhaps electricity—will come onto the market.

With these devices, the scientific and technological revolution will accelerate dramatically. Skeptics who



felt comfortable attacking alleged "subtle mistakes" in cold fusion experiments, will be hard-pressed to deny these practical devices; they will certainly try. But money talks. When the largest industrial corporations in the world are forced to rush belatedly into cold fusion R&D—as some already have done, particularly in Japan, but increasingly in the United States—the controversy will be over.

The scientific establishment was and still is dead wrong about cold fusion—catastrophically so. Just as at the end of the 19th-century X rays and radioactivity shook things up, a hundred years later the nightmare for believers in "the end of science" has crawled out of the laboratory and is beginning to shatter contemporary illusions of scientific certainty.

There will come a time—one hopes and expects within the next few years—when cold fusion energy will be completely accepted by the scientific community. Apart from the scientific and technological consequences of the phenomenon itself being ratified, may we expect a change in the way the scientific establishment conducts its affairs? It is difficult to say.

The embarrassment of those who went far out of their way to criticize cold fusion and interfere with its development will be profound. The media and books have meticulously chronicled the statements of the opponents, so there will be no hiding from the record of verbal assaults and acts of censorship and suppression that were made way past the "eleventh hour." To cite but one example: Magician James Randi writing in the *American Physical Society News* (June, 1994), "The 'cold fusion' farce should have been tossed onto the trash heap long ago, but justifiable fear of legal actions by offended supporters has stifled opponents. . . . At the risk of being unbearably realistic, I must tell you that Elvis Presley is really dead, the sky is not falling, perpetual motion is a chimera, cold fusion is a dead duck, the Earth is not flat, and the fault lies not in our stars, but in ourselves."

We might expect that *some* opponents will come forth with apologies for their behavior, but if the past is any guide, most will just silently slip away. It will not be as easy for magazine editors such as John Maddox, formerly of *Nature*. They will be obliged to begin treating cold fusion scientifically. Maddox will have to do some fancy footwork to explain his past policies. At least *some* journalists, who adopted a generally negative line, may turn on their former mentors in hot fusion and high-energy nuclear physics. That would be a way for them to salvage their own reputations.

Even with massive attempts to rewrite the history of the past eight years, the public may well not be fooled this time. They will see clearly what the entrenched scientific establishment did to one of the most important scientific discoveries of our age. Led by political commentators who normally don't interest themselves in scientific controversies or science policy, the people will be outraged at government-university malfeasance in the cold fusion affair. Then it may then be much more difficult for the scientific establishment

to defend its expensive programs. The question will be, "Why were billions of dollars lavished on the SSC and hot fusion, while nothing was spent on cold fusion—except to pay the hot fusion people to knock it down?"

Following the anti-cold fusion debacle, it is possible that a new science paradigm may gain wider currency, in which reports of unusual phenomena will be treated with the scientific respect they deserve. On the other hand, it could turn out to be just business-as-usual in science, with few lessons learned. That is hard for me to conceive, but stranger things have happened, have they not? It is certain, however, that it will eventually be impossible for a scientist to say of some new disputed anomaly, "That's nonsense, just like cold fusion." ■

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He knows nothing; he thinks he knows everything—that clearly points to a political career.

—George Bernard Shaw

The measure of a man's life is the well-spending of it, and not the length.

—Plutarch