

ESP and Cold Fusion

Parallels in Pseudoscience

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The Utopian Quests

By the late nineteenth century, science was well established in the public mind as the primary method by which useful knowledge of the material universe is obtained. Surely, it was thought, if science can discover cathode rays and radio waves, then it should easily authenticate a phenomenon that is far more widely experienced: the supernatural power of the human mind. Non-physical, “psychic” energy appeared to be everywhere, as an integral part of human experience. Indeed, psychic forces are seemingly built into the cores, the souls, of each of us. It should be just a matter of securing the evidence with the hard cement of scientific procedure. At least this was the view of many Victorian scientists, and so was begun a program to verify psychic phenomena scientifically, a task that has continued without success until the current day.

By the time the fourth decade of the twentieth century was underway, the search for psychic energy had stalled. The huge database of anecdotal human testimony proved too unreliable, too easy to explain away as subjective desire, fakery, or delusion. Whenever serious attempts were made to gather objective data under controlled conditions, plausible explanations such as trickery or simple coincidence were readily found--if not by the investigators, then by their critics. Although these plausibilities were not always conclusively proven, they were never conclusively ruled out. And, as long as ordinary explanations for reports of suggested psychic phenomena

remained viable, the law of parsimony prevented extraordinary explanations, such as psychic energy, from being written into the annals of scientific knowledge.

Despite what was by then over a half-century of failure to verify scientifically the existence of psychic energy, the quest was not abandoned. In 1934, Duke University botanist-turned-parapsychologist Joseph Banks Rhine announced to the world that he had finally found the smoking gun. Not only does psychic energy exist, Rhine asserted, but it is widespread and common.

Rhine made this discovery after analyzing the data from a few simple card-guessing experiments, easily duplicated by family members across a dining table. His results were reported in a book called *Extra-Sensory Perception*.¹ They were sensational. Headlines everywhere announced that the ancient, intuitive belief that mind transcends matter was at last confirmed in a scientific laboratory.

On March 23, 1989, electrochemists Martin Fleischmann and B. Stanley Pons made an announcement of comparable world-shaking proportions. In a rudimentary test tube experiment, little more sophisticated than Rhine's dining table exercises, Fleischmann and Pons claimed that the energy of the sun had been harnessed. In one stroke, all the world's energy problems were solved for the foreseeable future. Utopia was around the corner as limitless energy, "too cheap to meter," soon would be available to cleanse the environment, cure disease, and produce the food and material for humanity to expand to the stars.²

Fleischmann and Pons said they had achieved "cold fusion," nuclear fusion reactions that occur at room temperature instead of the millions of degrees that conventional physics wisdom said was required.³ This they claimed to accomplish by squeezing deuterons

(nuclei of heavy hydrogen) inside the crystal lattice of the metal palladium so that the deuterons fused into heavier elements, with the release of far more energy than was possible chemically. In a few weeks of work in their small lab at the University of Utah, they appeared to have succeeded where giant labs all over the world had failed after decades of costly experimentation.⁴

Telling the World

J.B. Rhine became an instant media superstar after announcing that he had demonstrated ESP. But he experienced less success in convincing scientific journals to publish his work. The experts called upon to referee his papers raised many questions about statistics, controls against fraud, and replication.

At first Rhine made a serious attempt to answer the criticisms, performing more experiments with increasingly better controls. Unfortunately, the effect seemed to fade as the experiments got better. Under the pressure of the spotlight, he was forced to perform and soon bypassed his critics, who never were satisfied anyway. When the *Journal of General Psychology* rejected a Rhine paper because it was “propagandist” in form, he started a new journal, with himself as co-editor.⁵ Through the efforts of Margaret Mead and other notables, parapsychology eventually obtained formal recognition within the American scientific community. However, it has always remained on the fringes--more pseudoscience than science.

Fleischmann and Pons announced their discovery of cold fusion in a press conference just 12 days after submitting a report to the *Journal of Electroanalytical Chemistry*.⁶ These actions were taken prior to making a presentation in front of peers at a scientific conference, or even a departmental seminar--a highly unconventional procedure. An

unwritten rule in science holds that press announcements of new discoveries should be delayed until the date of publication of the results in a scientific journal, not simply the date of submission. This allows for the conventional process of peer review to take its course outside the glare of publicity.

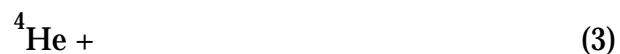
The day after their press conference, Fleischmann and Pons submitted a paper to the British journal *Nature* that was evidently similar to that sent to *J. Elec. Chem.* When the *Nature* paper was returned with questions from the reviewers, the chemists withdrew it, protesting that they were too busy to address the reviewers' concerns. *J. Elec. Chem.* was less fussy and accepted the paper immediately.

Reactions

From the beginning of the cold fusion saga, most physicists were highly skeptical while some in the chemistry community welcomed Fleischmann and Pons as heroes. A bit of healthy inter-professional rivalry was evident. The president of the American Chemical Society, Clayton Callis, was ecstatic that chemists had "come to the rescue" of the physicists who had not succeeded in controlling fusion with their expensive hot fusion experiments.⁷ But as the facts gradually worked their way through the forest of media hype, most chemists soon joined in the ranks of cold fusion skeptics.

A series of revelations inexorably squeezed all credibility from cold fusion research in the eyes of most knowledgeable observers. First, Fleischmann's and Pons' methodology was so questionable, so open to criticism on every front, that even had their claims turned out to be valid, many scientists would have been left with a bad taste in their mouths. But, beyond that, the claims were not validated. Let me examine some of the technical issues.

The main nuclear reactions known to occur when two deuterons come together are:



Here standard nuclear physics notation is used, where n is a neutron, p is a proton, γ is a gamma-ray (high energy photon), and nuclei are indicated by their chemical symbols with the number of protons plus neutrons comprising the nucleus given as a superscript. For example, the most common nucleus of the helium atom, ${}^4\text{He}$, contains two protons and two neutrons, while the isotope ${}^3\text{He}$ contains two protons and one neutron. The three isotopes of hydrogen are: ${}^1\text{H} = \text{p}$ (the proton); ${}^2\text{H}$ (the deuteron: one proton, one neutron); and ${}^3\text{H}$ (the triton: one proton, two neutrons).

These three nuclear reactions are all observed at higher energies (that is, higher than room temperature). However, (3) is far weaker than (1) or (2) for a fundamental reason: It is electromagnetic, as evidenced by the gamma-ray, while the other two are strong-nuclear. The theoretical rate for the third reaction is about ten million times lower than the first two, agreeing with what is observed in conventional experiments.

To demonstrate that cold fusion qualifies as a promising practical energy source, significant excess energy output must be measured. The issue is a quantitative one, and obtaining reliable numbers proved to be tricky. The experiments did not power themselves, as they would be expected to do in practical use; they were plugged into the laboratory wall outlet. They stopped when the power failed. In all cases of which

I am aware, more energy went in than was directly measured coming out and the claim of net energy production rested on the estimation of certain large theoretical corrections for energy lost in the apparatus as heat and gas. Furthermore, while at a given instant net power out may have been observed, this could have simply resulted from stored energy previously input--like a battery.⁸

Perhaps some small amount of energy was being produced by an unexceptional chemical or non-nuclear physical process not yet fully understood, but not miraculous either. However, this is not what was claimed. Proponents insisted that the energy released in cold fusion was far too large to have a conventional explanation. They asserted that the reaction must be nuclear or something even more exotic.

To unequivocally demonstrate that a nuclear reaction is responsible, nuclear reaction products, such as neutrons or gamma-rays, must be found at intensities far above the usual backgrounds in the laboratory. Again the matter is quantitative, and the fact that a few excess neutrons were occasionally reported to great fanfare proved little. Indeed, cold fusion is expected to occur at some very low level, with no potential consequence as an energy source. However, in order to generate one watt of energy, on the order of a trillion neutrons, protons, or gamma-ray photons must be given off each second. These would be very hard to miss, even by experimenters lacking special expertise and tools.

Radiation Revelations

Fleischmann and Pons claimed evidence for some low level nuclear radiation. It was far below the amount needed to be consistent with their energy output claims, but could still have signaled a nuclear reaction within their apparatus--a remarkable event nevertheless.

Their original paper contains a figure that is purported to be an energy spectrum of gamma rays observed to emanate from their apparatus during heat production. The authors asserted that these gamma-rays were a secondary product of neutrons produced in reaction (1), resulting when neutrons combined with protons in the water within the cold fusion cell to produce deuterons by a process called “neutron capture.” Any elementary nuclear physics textbook will tell you that the binding energy of the deuteron is 2.2 MeV (Million electron-Volts), and so the emitted gamma-ray should have a spectrum that peaks at exactly this value.

A gamma-ray spectrum had been included in the *Nature* manuscript, which we recall was submitted two weeks after the *J. Elec. Chem.* paper. A figure in the *Nature* paper showed the spectral peak at 2.5 MeV. The original *J. Elec. Chem.* manuscript reportedly contained the same figure. However, the version eventually published has the identical data points as the *Nature* manuscript, but plotted with different scales on both axes. The peak is centered “correctly” at 2.2 MeV. No satisfactory explanation has ever been given for this alteration.

Nuclear experts, seeing the published spectrum, insisted that its shape was all wrong, unphysically narrow and not exhibiting the “Compton edge” present in other experiments and required by theory. They also asked Fleischmann and Pons to show the complete spectrum, so that nearby peaks caused by natural radioactivity could be used for calibration. When this was done, the “signal” was back at 2.5 MeV.⁹

University of Utah physicists did not have a hint of the work being done over in Chemistry until the March 23 press conference. They were flabbergasted.¹⁰ A number of their faculty were expert in the detection of nuclear radiation and could not imagine why they were

never consulted. When, as the result of outside pressure, they were finally brought in, they assembled sensitive equipment in the chemists' laboratory and made measurements over several weeks. They found no evidence for any of the radiations that should accompany nuclear processes.¹¹ Pons later said that the apparatus was not working at the time--though they had continued to present positive results during that period. Well, maybe. In any case, nuclear radiation from the Utah apparatus was not confirmed.

In the weeks and months following the press conference, nuclear laboratories all over the world attempted to replicate cold fusion. When none found any convincing sign of neutrons at the required high intensity, cold fusion proponents suggested that perhaps few neutrons are produced. Rather, reaction (2) involving tritium plus proton (${}^3\text{H} + \text{p}$) production may be primarily responsible for the energy production. Some laboratories had reported seeing tritium, although not in association with heat production, nor with the expected by-products that would be produced by interactions of the accompanying 3 MeV protons. These results were almost certainly due to contamination. In the case of one laboratory, there was even a suspicion of skullduggery, with suggested surreptitious spiking of the sample with tritium, possibly the contrivance of hoaxers.¹² Perhaps excess, inexplicable tritium is present, but those who claim so have the burden of proof. They must also explain the missing protons.

Conventional deuteron fusion by the normally dominant reactions (1) and (2) is almost certainly not happening. In fact, incontrovertible evidence for this exists: Fleischmann and Pons, at this writing, are still alive! With the huge heat output being claimed, the radiation that should have been released would have killed anyone nearby. (Kids, don't try this at home.)

Too Many Tooth Fairies

When the evidence for ESP began to diminish with increasing laboratory controls, J. B. Rhine interpreted this as a property of the phenomenon--the so-called *decline effect*. When ESP did not occur with skeptical experts present in the laboratory, it was attributed to the *observer effect*. Einstein had said that in order to convince him that ESP is real, it should fall off with distance as its energy spreads out over a larger area. Anything else would violate the law of conservation of energy. When the specific experiment conducted to test this *distance effect* failed to show the expected falloff, Rhine concluded that ESP was not a physical phenomenon like electromagnetism. Psychic energy, it was inferred, is not conserved.

So, as its scientific support faded away, ESP evolved from what was at first interpreted as a possible natural phenomenon, not necessarily inconsistent with known science, to one that gradually took on the aspect of the miraculous, capable of violating natural law.

Cold fusion promoters have similarly begun to trust in miracles rather than science. As was the case with the ESP decline and observer effects, and absence of a distance effect, the irreproducibility of cold fusion has been treated as a property to be explained, rather than as a signal that the phenomenon simply does not exist. It was represented as a phenomenon that transcended normal science. And, since no known nuclear fusion reaction can possibly be producing the energy output claimed, the faithful proposed a double miracle.

First, they suggested that the normally very low-rate reaction (3), in which ^4He is produced, is the primary cold fusion energy source. Some labs reported seeing ^4He , although measuring it is as tricky as measuring neutrons and tritium and the unsophisticated can be easily

fooled by natural backgrounds.

Indeed, fusion to ^4He is the most energetic of the three deuteron fusion reactions, generating 24 MeV of energy in each reaction, almost ten times higher than reactions (1) and (2). This energy is normally carried off by a gamma-ray. However, as noted above, ^4He fusion occurs at a rate 10 million times slower than the ^3He and ^3H reactions because of its electromagnetic nature, and so should only account for about a millionth of the total energy output. Perhaps ^4He production becomes favored at room temperature--although no one can imagine why.

This was the first miracle proposed, the first invocation of the Tooth Fairy. Theoretical physicists are normally allowed to invoke the Tooth Fairy once in their more speculative presentations. However, cold fusion theorists had to invoke the Tooth Fairy a second time to explain why no one then saw the slightest hint of 24 MeV gamma-rays, when they should have appeared in the billions.

Gamma-rays have wavelengths thousands of times smaller than the spacings between atoms. Some will interact with individual atoms, but most will pass right on through and be detected outside the apparatus. They are even more penetrating than the longer wavelength X-rays. However, as we have seen, significant numbers of gamma-rays or any other nuclear particles are not detected in cold fusion experiments. Skeptics took this as evidence against cold fusion. Believers took it as a miraculous property to be explained by a second call on the Tooth Fairy.

This second miracle occurs, according to believers, when the energy released in the reaction is absorbed by the palladium lattice as a whole, converting directly into heat rather than being carried off by

gamma-rays. Processes of this sort can in fact happen at low photon energies, where the photon wavelengths are large compared to the distances between atoms and the photons behave as waves rather than as point particles. A beam of visible light, for example, will transfer energy to an atomic lattice as a whole. However, this cannot happen for 24 MeV photons without violating well-established laws of physics.

The uncertainty principle of quantum mechanics will allow 24 MeV of energy to be transferred “virtually” to the lattice, that is, without gamma-rays, provided it happens in less than the order of 10^{-23} second. However, since atoms are typically spaced about 10^{-8} centimeter apart, and the speed of light is 3×10^{10} centimeters per second, this transfer of energy can happen only at speeds tens of thousands of times the speed of light. That is, it must violate one of the prime precepts of Einstein’s theory of relativity, that no motion can exceed the speed of light.

At the Second Annual Cold Fusion Conference, held June 20 through July 4, 1991, in Como, Italy, the faithful speculated about the Einstein-Podolsky-Rosen (EPR) Paradox of quantum mechanics and how that may allow for superluminal signal transfer of energy to the lattice. Interestingly, this is the same mechanism invoked by ESP believers to explain their imagined instantaneous transfer of psychic energy from mind to mind throughout the universe.¹³ Perhaps the holistic field of “cosmic consciousness” that purportedly accounts for ESP, the powers of Transcendental Meditation, and the efficacy of homeopathic nostrums is also responsible for superluminal energy transfer between the atoms of the palladium lattice in cold fusion!

But superluminal, holistic processes are unknown outside of Shirleyland. Still, cold fusion believers insisted that something of this

sort is happening. Visions of paradigms danced in their heads. Now they fantasized that they had not only solved the world's energy problems, but produced a fundamental revolution in physics to boot-- finally destroying the hated reductionism of modern physics and chemistry. Cold fusion and ESP were one!

ESP believers had taken the lack of physical signals for ESP as evidence that the process is not physical, rather than drawing the more economical conclusion that ESP is simply non-existent. Similarly, cold fusion believers refused to consider the far more economical explanation, that they were not seeing anything of great significance and never did.

On the Attack

After the Utah physicists who looked for neutrons around the Fleischmann and Pons apparatus published their results in *Nature*, they received threatening letters from the chemists' lawyer that were later withdrawn after intense outrage from the scientific community.

I don't know if Rhine ever sued a critic. Perhaps that was not the thing to do in those kinder, gentler days, and he had a reputation as a gentleman. But in 1987, I was a co-defendant, along with CSICOP, its chairman Paul Kurtz, magician James Randi, the University of Hawaii, and several colleagues in a suit brought by a Hawaii psychic who claimed we had defamed him by questioning his public statements that mental telepathy is a phenomenon that is established worldwide. Parapsychologists everywhere rushed to his support. The judge ruled the suit frivolous and tossed it out of court, but it still cost CSICOP and the taxpayers of Hawaii considerable money in legal costs.

Concurrently, Randi and the Committee for the Investigation into Claims of the Paranormal (CSICOP) was sued by famed psychic Uri

Geller. Geller apparently discovered that, in America, critics who have no deep-pocket source of funds can be effectively silenced by bringing suit, even when that suit is absent of merit. Geller, a millionaire who lives on a lavish estate in England, also filed three lawsuits against me, in London, Honolulu, and Miami, over a statement made in my book *Physics and Psychics*.¹⁴ After losing the suits in Miami and Hawaii, and the one against CSICOP, Geller has settled with a considerable financial loss.

Cosmic Delusions

Pseudoscience itself is a phenomenon. Since science is so successful, many outside of science attempt to ride on its back to fame and fortune. They have found that by labelling something “scientific” they can gain a certain credibility with an undiscerning public. One sees this in newspaper ads for astrologers and chiropractors, and those tapes peddled on cable TV that tell us we can solve all our problems by just thinking we can.

J. B. Rhine and those who followed his lead have not provided adequate evidence for the existence of ESP. Fleischmann and Pons, and those who followed their lead, have not provided adequate evidence for cold fusion.

Still, with no basis other than faith, the ESP and cold fusion faithful continue to press their case with religious fervor. Like parapsychology, cold fusion seems to have passed on from science to pseudoscience, carried on by a few diehards who have allowed their desires to overcome their reason. The parallels are striking. It seems no coincidence that the only U.S. laboratory that claimed agreement with Fleischmann and Pons on anomalous heat production was SRI International (formerly Stanford Research Institute --not affiliated with

Stanford University, though this connection is often claimed), the same organization that reported evidence for remote viewing and the ESP powers of Uri Geller.

The case studies of ESP and cold fusion bring out some characteristics of the science-pseudoscience interface. Not all unsuccessful scientific ideas degenerate into pseudoscience. Most die an honorable death of failure to be confirmed by reality. The proponents eventually give up and move on to more profitable activities. ESP and cold fusion live on, not because the data demand them, but because people want to believe them.

ESP and cold fusion are cosmic delusions, like astrology and the belief that UFOs are visitors from higher civilizations in space. Delusions prevent those who hold them from facing reality. They provide easy solutions to the problems of life. The existence of ESP would mean that the human mind is capable of overcoming the barriers of space and time, allowing us to avoid death. Cold fusion would free us from the tyranny of limited energy, allowing us to expand without limit. Even perfectly respectable scientists, whose prior work was carried out with integrity and competence, can fall victim to the siren call of glory and immortality when they imagine their research may be touching phenomena of such immense consequence.

The Final Word

One should not conclude that the ESP and cold fusion stories are examples of science gone wrong. Quite the contrary. In fact, the scientific method worked fine in both cases and is now in the process of having the final word. The pressures of publicity, big money, politics, and human aspirations did not significantly impede the remorseless

application of the critical method. No one prevented skeptics from freely stating their objections (although not always at believer conventions, where sometimes only “positive results” have been allowed to be presented).

While nothing in science is final, a strong consensus exists that ESP and cold fusion are sufficiently unpromising to warrant further investigation at this time. The followers of J. B. Rhine, Martin Fleischmann, and B. Stanley Pons should move on to something else.

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Notes

¹J. B. Rhine, *Extra-Sensory Perception*, Boston, Bruce Humphries, 1934.

²For a complete history of cold fusion through 1993, see Gary Taubes, *Bad Science: The Short Life and Weird Times of Cold Fusion*, New York, Random House, 1993.

³When I use the term “cold fusion” in this essay, it will refer to the

specific claim by Fleischmann, Pons, and their supporters that huge energy production is occurring. Cold fusion has been demonstrated to exist under muon catalysis, and may also occur in palladium, but at rates that are far too low to have any application as an energy source.

⁴Fleischmann and Pons have claimed that they worked for years on cold fusion before making public their results. But the evidence indicates that they were heavily occupied with many other unrelated projects over those years, and the specific experiment reported was done in just a few weeks. See the discussion in Reference 7.

⁵Seymour H. Mauskopf and Michael R. McVaugh, *The Elusive Science: Origins of Experimental Psychical Research*, Baltimore, The Johns Hopkins University Press, 1980, p. 146.

⁶Martin Fleischmann and B. Stanley Pons, *Journal of Electroanalytical Chemistry* **251**, 301 (1989).

⁷Frank Close, *Too Hot to Handle: The Race for Cold Fusion.*, Princeton, NJ, Princeton University Press, 1991 p. 147.

⁸The distinction between energy and power is important to understand here. Power is the rate of energy usage, normally measured in watts. A battery will have a net power output at a given time as it uses up its stored energy.

⁹For a detailed discussion of the matter of the moving gamma-ray peak, see Close, Ref. 7. The full gamma ray spectrum can be found in M. Fleischmann, S. Pons, M. Hawkins, and R. J. Hoffman, *Nature* **339**, 667 (1989). See the immediately following critique by R. D. Petrosso *et al.*

¹⁰When I encountered a friend who happened to be a Utah physicist that summer at a meeting in Ireland, I observed that he had underlined the portion of his name tag that said “Department of Physics” with a bold marker.

¹¹M. H. Salamon et al., *Nature* **344**, March 29, 1990, p. 401. For editorial commentary, see pp. 365 and 375 of the same issue.

¹²Gary Taubes, *Science*, June 15, 1990.

¹³For a detailed discussion see Victor J. Stenger, *The Unconscious Quantum: Metaphysics in Modern Physics and Cosmology*, Amherst, NY, Prometheus Books, 1995.

¹⁴Victor J. Stenger, *Physics and Psychics: The Search for a World Beyond the Senses*, Amherst, NY, Prometheus Books, 1990.