

**Excess Heat: Why Cold Fusion Research Prevailed** by Charles G. Beaudette. Bristol, ME: Oak Grove Press, 2000. 360 pp. \$36.95 cloth, ISBN 0-9678548-0-6; \$26.95 paper, ISBN 0-9678548-1-4. Distributed by Infinite Energy Press, P.O. Box 2816, Concord NH 03302-2816.

What a sub-title, “Why Cold Fusion Research Prevailed”; doesn’t everyone know it didn’t prevail? Evidently, then, this book is iconoclastic. It is also a superb piece of investigative reporting and analysis. Not only does it clarify what “cold fusion” is and whether or not it is spurious, it also clarifies its context of the contemporary face of science. Some of the salient points will be of special interest to anyone concerned with scientific anomalies.

Having compared notes about the book with several people, I can also praise it for being among those rare works that appeal more to the neutral or uncommitted than to the over-enthusiastic proponents or the dogmatic critics. That is underscored by a foreword from Sir Arthur Clarke and an introduction by a former Division Superintendent for solid-state physics at the Naval Research Laboratories.

Chapter 1 introduces the most telling point: the basic claim of Fleischmann and Pons was empirical—more power coming out than going in; but the claim was rejected on theoretical grounds because no known nuclear process could explain the observed amount of heat in absence of corresponding amounts of radiation, helium, or tritium. Beaudette reminds us that the proper test of an empirical claim is not whether it can be explained by current theory, but whether it is correct. If other people can corroborate the observation, the lack of explanation does not call for rejection of the empirical fact. Pierre Curie, after all, observed and reported that radium was always a little warmer than its surroundings without having an explanation to offer; Onnes reported the amazing fact of superconductivity for which theory offered no explanation; both won Nobel Prizes. The photographic-strobe lamp was a successful commercial reality before a scientific explanation for it had been reached (p. 249). (Chapter 13 drives home the point that a well-attested observation cannot be dismissed just because there is no available explanation for it; a point always at issue in scientific anomalies. Pressed as to why I think Loch Ness monsters are real, I cite the Dinsdale film of 1960: I have no explanation for what it shows, but there is no doubt that it is large and animate.)

In Chapter 2, Beaudette demonstrates how the nuclear-physics community rushed to hasty judgment, drawing the media along. In Chapter 3 he gives the background to Fleischmann’s hunch that the deuterium-palladium (D-Pd) system might catalyze nuclear reactions; the hunch was based on empirical substance and rational thought. At the same time Beaudette reminds us that “There is no implication here that this reasoning is correct. Many discoveries have been made by looking for one thing and quite unexpectedly finding something else of value” (p. 34). (A powerful but rarely cited justification for encouraging the pursuit of hunches.) There are fascinating tidbits throughout the

book, for example, a graduate student's recollection of his surprise that Fleischmann and Pons, finding one of their first experiments destroyed by an explosion, "had these looks on their faces as though they were the cat that had just swallowed the canary" (p. 35). That they found no radioactivity on that occasion may well have been the genesis of their notion that this must be a new, unknown nuclear process that produced much energy without a corresponding amount of high-energy particles or radiation.

Chapter 4 begins with a description of a power burst in a D-Pd system, observed by a competent scientist quite independent of Pons and Fleischmann. Nothing happens in the experiment "for weeks, maybe months. Then all of a sudden the readout device shows the cell has started taking off. And you say, 'Oh-oh, what's gone wrong now.' ... After a while it suddenly dawns on you that nothing is wrong. This is what it is supposed to do" (pp. 44–45). Pons and Fleischmann typically got excess heat only after weeks of electrolysis. They had found ways to avoid fouling of the electrodes over such long durations, no mean feat. Yet their claims were contradicted by some who tried experiments for a few days only, or at most a few weeks. How challenging the work is, is illustrated by the fact that McKubre, already skilled in the requisite types of experiments, still needed about 5 years and about \$6 million to confirm the claim of excess heat. McKubre's confirmation of the claim of excess heat, it is to be noted, was entirely independent. His previous experience allowed him to recognize the crucial role of loading: excess heat is observed only when the ratio of D to Pd atoms exceeds about 0.85–0.9. Beaudette suggests (and investigators of anomalies would heartily agree) that "Scientific methodology places the same intellectual discipline on the critic as on the experimenter" (p. 49). At the same time, "there exists ... a double standard of laboratory work: one ... sufficient to persuade the experimenter himself, and a higher one that is sufficient to persuade his peers" (p. 53). Those who find themselves convinced that the experiments are correct are acceptors, Beaudette points out; not, as the skeptics put it, "believers." He makes the further nice distinction (p. 81) between the corroboration of an experiment—others reporting the same thing—and the validation of the experiment: corroboration shows that the initial report was not a figment of imagination, but it does not exclude the possibility of some systematic error in the experiment (p. 154). A similarly nice distinction is made between evidence and proof (p. 156).

The pre-eminence of physics among the sciences and what role that played in the cold-fusion affair is described in Chapter 5. The physicists' hubris was illustrated when the head of the Physics Division at the National Science Foundation issued a public memorandum deploring that the Foundation was co-sponsoring a conference on cold fusion. Also in Chapter 5 is a discussion of Langmuir's description of "pathological science" and the logical errors made by "skeptics" in applying the concept. Langmuir had witnessed some of the experiments he criticized, and Wood's classic debunking of N-rays was based on his visit to the laboratory, whereas critics of cold fusion have felt able to de-

clare the calorimetry wrong without ever having seen it done. The rapid rush to negative judgment is held to detailed account in this chapter: "Putting together an ad hoc group to do surface-catalyzed electrochemistry was preposterous, like collecting some physicists to build a tokamak" (p. 69).

In Chapter 8 the critics are criticized in detail. Beveridge's classic "The Art of Scientific Investigation" is cited to the effect that in mature fields, outsiders are more likely to make revolutionary discoveries than the insider experts are. Arrhenius's discovery of electrolytic ionization affords an example of the difficulty of deciding who is insider and who outsider, when a new discovery is made. David Goodstein comes in for reproach here (as also later) for misunderstanding and misapplying Popper's notion of falsifiability: he "fits the Popper shoe to the physicist's foot" (p. 106). What after all is the significance of failures to replicate, in a new field whose parameters are not yet understood? "Imagine you have a lake ... and want to know if there are fish in it. You send out one hundred expert fishermen. ... When they return, ninety-five ... have caught no fish, and five ... are each holding up a fish. Now your question can be answered" (p. 107). By contrast, the cold-fusion critics took a vote, which carried the day 95 to 5.

The critics also overlooked how many variables the experiments involved, and the possibility of such threshold effects as the need to exceed a D/Pd ratio of 0.85 or more. Oversights of this kind are far from uncommon. It is very likely, for instance, that the self-repairing mechanisms of animals can overcome low dosages of toxic chemicals or radiation but are overwhelmed when the dose rate exceeds a certain threshold level; but even some "experts" extrapolate high-dose results linearly toward zero to reach conclusions so implausible as to border on absurdity, for example, that second-hand smoke is responsible for a calculable number of deaths.

Criticism of the critics continues in Chapter 9. That Fleischmann and Pons did not focus on control experiments with ordinary water is shown to be quite appropriate: they were not presuming that deuterium fusion was the cause of the excess heat, and their proper controls were inactive cells not generating excess heat. That their heat measurements were sound was demonstrated with control cells that gave no excess heat when treated and measured in exactly the same manner as the active cells. The critics were thrown back on insisting that some undiscovered flaw must exist in the calorimetry, just because insufficient nuclear products were observed. Thus the critics, not the acceptors, had jumped to conclusions about what the explanation for excess heat must be.

That excess heat has been validated is argued in Chapter 10. Some experiments are complicated. The proper criticism must be laboratory-centered, looking for errors in observation. Beveridge is again cited to good effect: "There is a very important distinction between a critical attitude of mind ... and a skeptical attitude. ... Perhaps the insistent skeptic serves a useful purpose in the community, but I admit it is not one which I admire" (p. 131). And Beaudette adds: "Commentary by the skeptics cannot be expected to con-

tribute to solving outstanding questions because the skeptics do not acknowledge those questions exist” (p. 133).

Differences in proper practice between different scientific specialties are illustrated. Chapter 11 goes into further detail about the case of Arrhenius. Ludwik Fleck’s discussion of the Wassermann test is nicely summarized, and its significance is pointed out, for deciding what degree of replication validates a scientific fact. Chapter 12 further reviews issues of validation, with telling comparisons between cold fusion and high-temperature superconductivity. In Chapter 14, Beaudette details the several independent investigators who have used different types of calorimetry to confirm the appearance—occasionally, not invariably—of excess power whose magnitude per atom marks the source as nuclear. Chapter 15 surveys reports of nuclear products, some of which are impressive.

How all this might be explained is discussed in “Theoretical Musings,” Chapter 16. Particularly enlightening is a clear exposition of Hagelstein’s ideas. It is arresting to read that “the major theoretical problem is not how to elude the Coulomb barrier; and it is not how to account for anomalously low neutron emission rates. . . . [Rather] our interest must be focused on the problem of anomalous energy transfer” (p. 231). If the solid electrode lattice can exchange energy with individual nuclei in particular ways, then “cold fusion” becomes no more surprising than lasers. (But also no less surprising: Charles Townes, the inventor of masers [the forerunners of lasers] recalls that his colleagues, Nobel laureates Rabi and Kusch, urged him to stop chasing such a will-o’-the-wisp because it would give their department a bad name; and both Niels Bohr and John von Neumann told Townes the maser was impossible even after he had demonstrated that it worked—see Townes, C. H. [May/June 2000]. *How the Laser Happened* [review]. *Infinite Energy*, 6, no. 31).

With “appropriate cautionary words,” Beaudette reports in Chapter 17 some claims of transmutation of elements that have been made in association with “cold fusion.” Chapter 18 has speculation about what applications of cold fusion the future may bring.

Chapter 19 is a concise, telling critique of the loudest nay-sayers. “The skeptic is one who will not accept an assumption that is fundamental to a field of study thereby leaving him blind to the research. Consequently his ‘criticisms’ are not useful to those to whom they are directed” (p. 259). The physicists needed to learn and talk about calorimetry if they were to address appropriately the claim made by Fleischmann and Pons; instead they just called them impossible because the nuclear products expected from gas-phase, plasma fusion had not been observed. But that is evasive and not proper scientific procedure: “Science does not give the skeptic or critic a free ride” (p. 265). Fleischmann had cited a 1930s paper from Rutherford’s lab reporting a nuclear reaction incited at exceptionally low excitation energies (p. 274); but what the skeptics have asked of cold fusion “is nothing less than a nuclear power plant of reduced size, but otherwise fully functional.” Another good point from Bev-

eridge is quoted: "It is not uncommon for opponents of an innovation to base their judgment on an 'all or nothing' attitude, i.e., since it does not provide a complete solution to the practical problem, it is no use." How crucial has become the role of the media is evident from the manner in which the American Physical Society reacted when the American Institute of Physics gave its Science Writing Award to Jerry Bishop, who had covered the cold-fusion saga in neutral fashion for the *Wall Street Journal*; rarely can an award have been presented with a more grudging annotation (pp. 266–268). Beaudette points out that the scientific community depends for its information about the broad field of science on those major scientific journals that reach a broad audience: *Nature*, *Science*, *Chemical & Engineering News*, *Scientific American*. All four have withheld from their readers the indubitable fact that dozens of competent researchers have continued to investigate cold fusion and to report continuing, indeed increasing reproducibility and insights.

Chapter 20 treats rather harshly David Goodstein's equivocal article about cold fusion in *American Scholar*. We are also reminded here that it is not easy to decide which specialty is most expert as to cold fusion; yet the media automatically turn to physicists to comment, as on most matters scientific. Beaudette also points out that individuals are freer than institutions to take a chance on a long shot; that is why the investigation of anomalies is a matter for independent scholars.

Why confusion has reigned over cold fusion is summarized in Chapter 21. Fleischmann and Pons made three claims that became entangled instead of being treated separately: deuterium-deuterium fusion; massive amounts of excess heat; and an unknown type of nuclear reaction in which energy production is not accompanied by lethal radiation. That the first claim was unwarranted and incompetently supported caused the other two to be equally dismissed, but "an absolute separation must be maintained in analysis between an observation and the cause of the observation" (p. 295). Galileo correctly identified mountains on the moon and satellites around Jupiter without having an explanation for them. The blame for sending cold fusion into an intellectual ghetto, Beaudette apportions thus: 60% to the Baltimore meeting of the American Physical Society and the four press conferences held on that occasion; 20% to *Nature* for refusing to publish Oriani's confirmation of excess heat in January 1990; 10% to the University of Utah administration; and 10% to Fleischmann and Pons for failing to share full data with colleagues at their own university and for getting nuclear measurements wrong without promptly admitting it. An eminently judicious assessment, as is the whole book.

John Maddox, long the editor of *Nature*, once delivered himself of a statement about cold fusion that remarkably combines fatuity and pompous arrogance: "It's dead. And it will remain dead for a long, long time" (p. 270).

No, Mr. Maddox. Instead, Beaudette's book is the last word about this matter, and the last laugh, and it is likely to remain so for a long, long time.

**Cold Fusion: Fire From Water.** Video by Infinite Energy (P.O. Box 2816, Concord, NH 03302-2816; [www.infinite-energy.com](http://www.infinite-energy.com)), 1999. 70 minutes. \$34.95 (\$44.95 outside the US). ISBN 1-892925-01-X.

This video is a nice supplement to Beaudette's recent book, *Excess Heat: Why Cold Fusion Research Prevailed*. The video features many of the chief actors in the cold fusion (CF) saga.

The video is technically impeccable. For the first 60 or so of its 70 minutes, it is hard to find any fault with its facts. The last 10 minutes are rather over-the-top with enthusiastic predictions of impending commercial units, but it is clear enough that these are simply opinions expressed by the people who are shown making the predictions.

The stage is set by a brief review of civilization's dependence on energy, and the depletion of and pollution from fossil-fuel resources. The announcement of "cold fusion" by Fleischmann and Pons, we are reminded, was soon followed by the Valdez oil-spill disaster. We are reminded too that tens of billions of dollars spent on tokamaks have brought controlled "hot" nuclear fusion apparently no closer.

CF was inconceivable to physicists, particularly since no radiation was detected from the electrochemical cells in which heat was said to be produced by nuclear reactions. Failures to replicate became common. Huizenga is shown classing CF as pathological science, and John Maddox pronouncing it dead and to remain dead "for a long, long time." Fleischmann responds that this is pathological criticism—criticism that continues long after it should have stopped.

Vignettes throughout the video show (as well as Fleischmann and Pons) Sir Arthur Clarke, John Bockris, Mike McKubre, Ed Storms and other central figures. All reveal themselves as impressively level-headed, reinforcing the detailed argument Beaudette gives in his book, that excess heat is unquestionably real. Storms carries conviction as he relates his own conversion from skeptic after he found tritium being generated, and then heard that two others independently were finding it too. A nice tidbit is added by Passell of the Electric Power Research Institute (EPRI), recounting that a couple of the members of the committee that recommended against federal funding of CF nevertheless privately asked Passell about getting funds from EPRI.

The video is sound also on the difficulty of explaining CF, and the independence from that of the *fact* of the phenomenon. McKubre makes a nice point, that the difficulty is not in finding an explanation but in deciding which of the several offered ones to use as a guide for experimental investigation.

Nuclear transformations involving heavier elements than hydrogen are mentioned toward the end, and the video concludes with expressions of sentiment from various parties that commercial applications are not only feasible but even impending. The ease with which little CF units can replace fuel cells, in cars for example, is pointed out. These perhaps overly optimistic predictions

notwithstanding, the video is a solid documentary, exceeding in factual responsibility many of the documentaries prevalent on television.

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**Psychic: True Paranormal Experiences** by Hans Holzer. New York: Smithmark. x + 350 pp. (hard cover). ISBN 0-7651-0953-0.

Let me say at once that this is not a book that is likely to commend itself to readers of the *Journal of Scientific Exploration*. There is no bibliography, references, or other scholarly appurtenances. There is an index, but it does not seem to have been compiled with much care, as it lists Adlai Stevenson but not Ian Stevenson, although the latter is mentioned briefly in the text in the chapter dealing with reincarnation. Hereward Carrington is mentioned, but his first name is misspelled "Herewood." These are minor blemishes, but one soon realizes that this is a work of "pop-parapsychology," an adventure story for those who enjoy spooky tales rather than a serious contribution to the field.

Most of the episodes discussed relate to the author's experiences in the 1960s and 1970s, and much prominence is given to the medium Sybil Leek. The index gives her more citations than anyone else. The author was impressed by the fact that: "she was able to pinpoint the actual location of Camelot in England." But how, one may well wonder, does the author know that she got it right? It is my understanding that scholars now consider that the Arthurian legends are wholly fictitious. If that is so, then the only real "Camelot" would be the circle of favorites with which the late John F. Kennedy surrounded himself!

A large portion of the book is devoted to psychic photography. The only case of psychic photography that I know anything much about is that of Ted Serios, who was investigated so intensively by the late Jule Eisenbud. Holzer mentions Serios, but I cannot think it is helpful to be told: "Serios is capable of what we call astral projection. In the out-of-body states he visits distant places in a flash, then almost instantly returns to his physical body and records by his etheric eyes onto Polaroid film." The case of Ted Serios is, I consider, one of the most remarkable paranormal cases of this century, but I cannot see how invoking "astral projection" or "etheric eyes" (whatever they may be) throws any light on it.

The author, clearly, is very fond of ghosts, and the obliging Sybil Leek is often brought in in an effort to get at the root of some case which the author has pursued, whether on the East Coast or the West Coast of the United