Cold fusion

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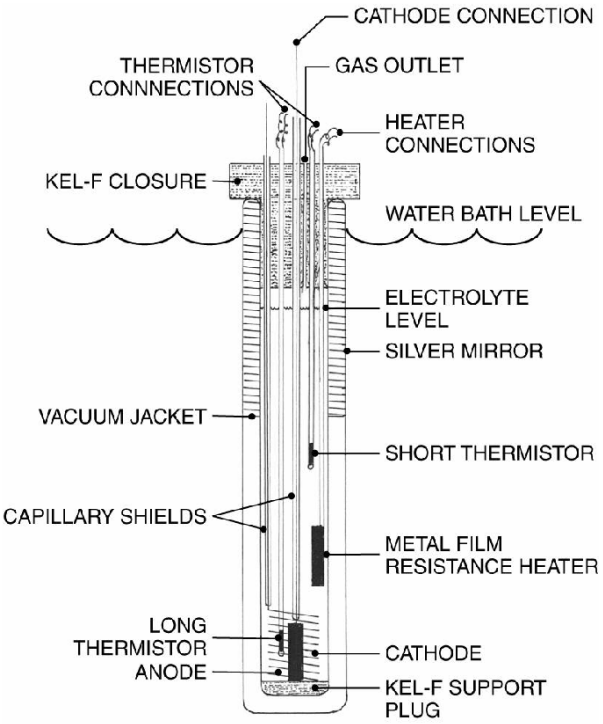
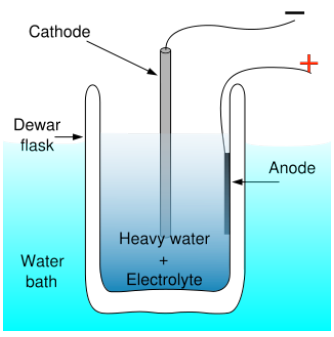


Cold fusion refers to a postulated nuclear fusion process of unknown mechanism offered to explain a group of disputed experimental results first reported by electrochemists Stanley Pons and Martin Fleischmann. More broadly, but less commonly, it can be used to refer to any real or proposed routes for nuclear fusion to occur without the extremely high temperatures (millions of degrees Celsius) required for thermonuclear fusion.

Cold fusion made worldwide news headlines in March 1989, when Fleischmann and Pons held a news conference in which they reported producing nuclear fusion in a tabletop experiment involving electrolysis of heavy water on a palladium (Pd) electrode.[1] They reported anomalous heat production ("excess heat") of a magnitude they asserted would defy explanation except in terms of nuclear processes.[2] They further reported measuring small amounts of nuclear reaction byproducts, including neutrons and tritium.[3] These reports raised hopes of a cheap and abundant source of energy.[4]



Enthusiasm turned to skepticism and scorn[5] as a long series of failed replication attempts were weighed in view of several theoretical reasons cold fusion should not be possible, the discovery of possible sources of experimental error, and finally the discovery that Fleischmann and Pons had not actually detected nuclear reaction byproducts.[6] By late 1989, most scientists considered cold fusion claims dead,[7] and cold fusion subsequently gained a reputation as pathological science.[8] However, some researchers continue to investigate cold fusion and publish their findings at conferences, in books, and scientific journals.[9] The field is sometimes referred to as **low energy nuclear reaction** (LENR) studies or **condensed matter nuclear science**.[10]

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Fleischmann-Pons announcement

Martin Fleischmann of the University of Southampton and Stanley Pons of the University of Utah hypothesized that the high compression ratio and mobility of deuterium that could be achieved within palladium metal using electrolysis might result in nuclear fusion.[15] To investigate, they conducted electrolysis experiments using a palladium cathode and heavy water within a calorimeter, an insulated vessel designed to measure process heat. Current was applied continuously for many weeks, with the heavy water being renewed at intervals.[15] Some deuterium was thought to be accumulating within the cathode, but most was allowed to bubble out of the cell, joining oxygen produced at the anode.[16] For most of the time, the power input to the cell was equal to the calculated power leaving the cell within measurement accuracy, and the cell temperature was stable at around 30 °C. But then, at some point (and in some of the experiments), the temperature rose suddenly to about 50 °C without changes in the input power. These high temperature phases would last for two days or more and would repeat several times in any given experiment once they had occurred. The calculated power leaving the cell was significantly higher than the input power during these high temperature phases. Eventually the high temperature phases would no longer occur within a particular cell.[16]

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In 1988, Fleischmann and Pons applied to the United States Department of Energy for funding towards a larger series of experiments. Up to this point they had been funding their experiments using a small device built with $100,000 out-of-pocket.[17] The grant proposal was turned over for peer review, and one of the reviewers was Steven E. Jones of Brigham Young University.[17] Jones had worked on muon-catalyzed fusion for some time, and had written an article on the topic entitled "Cold nuclear fusion" that had been published in Scientific American in July 1987. Fleischmann and Pons and co-workers met with Jones and co-workers on occasion in Utah to share research and techniques. During this time, Fleischmann and Pons described their experiments as generating considerable "excess energy", in the sense that it could not be explained by chemical reactions alone.[18] They felt that such a discovery could bear significant commercial value and would be entitled to patent protection. Jones, however, was measuring neutron flux, which was not of commercial interest.[17] In order to avoid problems in the future, the teams appeared to agree to simultaneously publish their results, although their accounts of their March 6 meeting differ.[19]

In mid-March, both research teams were ready to publish their findings, and Fleischmann and Jones had agreed to meet at an airport on March 24 to send their papers to Nature via FedEx.[19] Fleischmann and Pons, however, broke their apparent agreement, submitting their paper to the Journal of Electroanalytical Chemistry on March 11, and disclosing their work via a press conference on March 23.[17] Jones, upset, faxed in his paper to Nature after the press conference.[19]

Reaction to the announcement

This article may be inaccurate or unbalanced in favor of certain viewpoints. Please improve the article by adding information on neglected viewpoints, or discuss the issue on the talk page.

Fleischmann and Pons' anouncement drew wide media attention. Scores of laboratories in the United States and abroad attempted to repeat the experiments.[20] A few reported success, many others failure.[20] Even those reporting success had difficulty reproducing Fleischmann and Pons' results.[21] One of the more prominent reports of success came from a group at the Georgia Institute of Technology, which observed neutron production.[22] The Georgia Tech group later retracted their announcement.[23] Another team, headed by Robert Huggins at Stanford University also reported early success,[24] but this too was refuted.[7] For weeks, competing claims, counterclaims and suggested explanations kept what was referred to as "cold fusion" or "fusion confusion" in the news.[25]

In May 1989, the American Physical Society held a session on cold fusion, at which were heard many reports of experiments that failed to produce evidence of cold fusion. At the end of the session, eight of the nine leading speakers stated they considered the initial Fleischmann and Pons' claim dead.[20]

In April 1989, Fleischmann and Pons published a "preliminary note" in the Journal of Electroanalytical Chemistry.[15] This paper notably showed a gamma peak without its corresponding Compton edge, which indicated they had made a mistake in claiming evidence of fusion byproducts.[26][27] The preliminary note was followed up a year later with a much longer paper that went into details of calorimetry but did not include any nuclear measurements.[18]

In July and November 1989, Nature published papers critical of cold fusion claims.[28][29]

Nevertheless, Fleischmann and Pons and a number of other researchers who found positive results remained convinced of their findings.[20] In August 1989, the state of Utah invested $4.5 million to create the National Cold Fusion Institute.[30]

The United States Department of Energy organized a special panel to review cold fusion theory and research.[31] The panel issued its report in November 1989, concluding that results as of that date did not present convincing evidence that useful sources of energy would result from phenomena attributed to cold fusion.[32] The panel noted the inconsistency of reports of excess heat and the greater inconsistency of reports of nuclear reaction byproducts. Nuclear fusion of the type postulated would be inconsistent with current understanding and would require the invention of an entirely new nuclear process. The panel was against special funding for cold fusion research, but supported

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modest funding of "focused experiments within the general funding system."[33]

In the ensuing years, several books came out critical of cold fusion research methods and the conduct of cold fusion researchers.[34]

1. ^ Voss 1999
2. ^ Fleischmann & Pons 1989, p. 301 ("It is inconceivable that this [amount of heat] could be due to anything but nuclear processes.")
3. ^ Fleischmann & Pons 1989, p. 301 ("We realise that the results reported here raise more questions than they provide answers . . .")
4. ^ Browne 1989, para. 1
5. ^ Browne (1989-05-03). "Fusion Claims is Greeted With Scorn by Physicists". *The New York Times*: pp. A1, A22.
6. ^ Browne 1989,Close 1992, Huizenga 1993,Taubes 1993
7. ^ ***a b*** Browne, Malcolm W. 3 May 1989. Physicists Debunk Claim Of a New Kind of Fusion, *The New York Times*
8. ^ "US will give cold fusion a second look". New York Times. Retrieved on 2009-02-08.
9. ^ Voss 1999,Platt 1998,Goodstein 1994,Van Noorden 2007,Beaudette 2002,Feder 2005,Hutchinson 2006,Kruglinksi 2006,Adam 2005
10. ~~^ Biberian 2007,Hagelstein et al. 2004~~
11. ~~^ Choi 2005,Feder 2005,US DOE 2004~~
12. ~~^ ***a b c d*** US DOE 1989, p. 7~~
13. ~~^ Paneth and Peters 1926~~
14. ~~^ Kowalski 2004, II.A2~~
15. ^ ***a b c*** Fleischmann & Pons 1989, p. 301
16. ^ ***a b*** Fleischmann et al. 1990
17. ^ ***a b c d*** Crease & Samios 1989, p. V1
18. ^ ***a b*** Fleischmann et al. 1990, p. 293
19. ^ ***a b c*** Lewenstein 1994, p. 8
20. ^ ***a b c d*** Browne 1989
21. ^ Schaffer 1999, p. 1
22. ^ Broad 1989
23. ^ Wilford 1989
24. ^ Broad, William J. 19 April 1989. Stanford Reports Success, *The New York Times*.
25. ^ Bowen 1989
26. ^ Tate 1989, p. 1
27. ^ Platt 1998
28. ^ Gai et al. 1989, pp. 29-34
29. ^ Williams et al. 1989, pp. 375-384
30. ^ Joyce 1990
31. ^ US DOE 1989, p. 39
32. ^ US DOE 1989, p. 36
33. ^ US DOE 1989, p. 37
34. ^ Taubes 1993, Close 1992, Huizenga 1993, Park 2000}