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Lessons from cold fusion, 30 years on

Why revisit long-discredited claims for a source of abundant energy, asks **Philip Ball***? Because we are still learning how to treat pathological science.*

In early 1989, chemists Martin Fleischmann and Stanley Pons at the University of Utah, Salt Lake City, made a claim that shocked and galvanized chemists and physicists, and excited society with its potential implications for clean, cheap energy.

At a press conference, Fleishmann and Pons announced what would become known as cold fusion — the nuclear fusion of hydrogen at room temperature rather than inside a star. They described a startling process in heavy water (that is, water molecules with deuterium atoms replacing the normal hydrogens) in which the electrolysis of a salt solution could, so they said, make deuterium atoms absorb into a palladium electrode at such a high density that their nuclei merged, producing energy and the neutron and γ-ray emissions that are telltale signs of fusion.

The findings didn't stand up to the storm of scrutiny that followed. As a recent recruit to the physical sciences editorial team at *Nature*, to which Fleischmann and Pons had submitted their paper, I got a whirlwind introduction to the politics of scientific controversy.

This week's publication of a study funded by Google (C. P. Berlinguette *et al. Nature* https://doi.org/10.1038/s41586-019-1256-6; 2019) that sought (unsuccessfully) to replicate the claims and to search for deuterium fusion led me to reflect on that past. My conclusion? The sociology is at least as instructive as the science.

From the replication crisis of the social and life sciences to the mistaken report of faster-than-light neutrinos in high-energy physics, science is facing ever more claims that both defy conventional wisdom and are based on evidence at the threshold of what analyses or instruments can detect. Adjudicating such claims demands a community of researchers that is united in the spirit of inquiry, despite disagreements about evidence or interpretation. Cold fusion showed us the dangers of polarization, the distorting influence of commercial interests and the importance of being open about methods, data and mistakes.

The concept of cold fusion unravelled within weeks of its debut. Even secondary-school students joined the flocks of scientists who were trying to reproduce the findings. A few groups of researchers claimed to have verified the reaction's excess heat or fusion-related signals, but most experiments revealed nothing unusual. Fleischmann and Pons made their claim in March; by June it had been widely dismissed as illusory — or worse.

For some, cold fusion represented a classic example of pathological science. This term was coined in the 1950s to describe a striking claim that conflicts with previous experience, that is based on effects that are difficult to detect and that is defended against criticism by ad hoc excuses. In this view, cold fusion joins an insalubrious list that includes the N-rays of 1903, the polywater affair of the late 1960s and the memory of water episode of the late 1980s.

Nature never published the manuscript by Fleischmann and Pons — the authors withdrew it to focus on follow-up work. But a paper reporting similar findings by a group at Brigham Young University in Provo, Utah, was published in April of that year (S. E. Jones *et al. Nature* **338**, 737–740; 1989). The only report at the time from Fleischmann and Pons was a short paper, lacking in detail, in the *Journal of Electroanalytical Chemistry* (M. Fleischmann & S. Pons *J. Electroanal. Chem.* **261**, 301–308; 1989).

Nature did publish follow-up studies by other groups, including one that used the actual equipment of Fleishmann and Pons (M. H. Salamon *et al. Nature* **344**, 401–405; 1990). None observed any hint of cold fusion, and no convincing evidence has since materialized.

The small community that insists that cold fusion is a genuine, if elusive, phenomenon is unlikely to be satisfied with the negative findings reported in this issue, in part because these findings suggest that interesting questions remain about the conditions under which fusion might occur.

WE SHOULD NOT TOO QUICKLY JUDGE SCIENTISTS WHO MAKE CONTROVERSIAL CLAIMS.

Although often held up as a textbook case of science's self-correcting capacity, the cold-fusion episode is instructive for how it brought out both the best and worst in scientists.

We should not too quickly judge, and thereby alienate, scientists who make controversial claims. The ridicule that was sometimes directed at Fleischmann and Pons was bound to make them double down. When researchers turn out to have been mistaken, they must be allowed a way back without disgrace. Nor should the science under scrutiny be reflexively regarded as being pathological. Some assertions at the time, along the lines of "I knew it was nonsense," scarcely exhibited the openness to surprise on which science depends.

Yet the architects of cold fusion were their own worst enemies. Fleischmann launched ad hominem attacks on his critics; he and Pons were obstructive about their methods. The ill-advised, short-lived attempt by their university to capitalize on cold fusion made matters worse. Some researchers faced unconscionable legal threats for simply trying to do good science. The discipline-led triumphalism — with chemists claiming to have achieved in a cheap test tube what physicists failed to do with high-tech equipment — was trite and divisive. Without a tolerant and collaborative spirit, feelings can rapidly sour.

Keeping a handle on such a fast-moving story in the days before the Internet meant that cutting and pasting required scissors and glue, and that sending a fax was the quickest way to share a document. Would the cold-fusion saga play out differently today, with social media, fake news and an even more urgent need for clean energy? Probably — but not necessarily for the better. ■

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