Social and Philosophical Aspects of a Scientific Controversy

Ludwik Kowalski

Professor Emeritus at Montclair State University, USA

kowalskiL@mail.montclair.edu

The field of Cold Fusion (CF), also called Condensed Matter Nuclear Science (CMNS), remains controversial. The original 1989 claim made by M. Fleischmann and S. Pons was that a chemical process in an electrolytic cell could initiate a thermonuclear reaction--fusion of two deuterium nuclei. Some investigators have confirmed the generation of unexplained thermal energy but their results were, and still are, not reproducible on demand. The same is true for more recent cold fusion claims, such as transmutation of chemical elements, accumulation of light nuclear byproducts (such as tritium and helium), and emission of charged nuclear particles.

The purpose of this presentation is to briefly describe the history of the field, focusing on the methodology of validation of scientific claims, on the original announcement of the excess heat discovery, and on conclusions reached by scientists participating in two US Department of Energy reviews of the field (1989 and 2004).

Why are scientific investigations usually more effective than investigations in any other field? This is due to the so-called "scientific method," a set of rules developed to deal with difficulties, especially with mistakes and controversies. Most scientific mistakes are recognized when new results are discussed with colleagues, or via the peer review process. Occasional errors in published papers are subsequently discovered during replications conducted by other scientists.

Scientific results, if valid, according to (1), must be reproducible on demand. "When errors are discovered, acknowledged and corrected, the scientific process moves quickly back on track, usually without either notice or comment in the public press." The scientific process, in other words, is self-corrective. The process might be slow but it works, more often than not. The purpose of this presentation is to analyze an ongoing CF controversy. Why is that controversy, started in 1989, unresolved? Because scientists are not infallible and what they do is not always consistent with scientific methodology.

Invalid claims made by experimental scientists can be discovered in two different ways: by performing similar experiments or by comparing the reported results to accepted theoretical predictions. The first approach is conceptually simple. Suppose several competent researchers fail to validate a result, using the described procedure. This is usually a good reason for not accepting the initial claim. Reproducibility on demand is an important scientific requirement. But suppose a reproducible result conflicts with an existing theory. What should be rejected, the experimental result or the theory?

A theory, in this context, is not just a hypothesis, or only a logical/mathematical

argument. It is a logical structure that is known to agree with a wide range of already verified experimental data. Scientists know the rule--theories guide but experiments decide. But they are very reluctant to abandon accepted theories. To be reluctant means to insist on additional verifications of new experimental results. Referring to such situations, Huizenga wrote: "There are occasionally surprises in science and one must be prepared for them." Theories are not carved in stone; scientists do not hesitate to modify or reject theories when necessary. Rejecting a highly reproducible experimental result "on theoretical grounds" would not be consistent with scientific methodology. Unlike mathematics,

science is based, in the final analysis, on experimental data, not on logical proofs.

This presentation is based on ten references. The CF controversy, as emphasized in the last paragraph, is not only a conflict between two groups of scientists; it can also be viewed as a clash between scientists and bureaucrats acting in the name of society. The episode is unprecedented in terms of its duration, intensity, and caliber of adversaries on both sides of the divide. Both Fleischmann and Huizenga will be remembered as indisputable leaders in their fields of nuclear science and electrochemistry. But how will the long-lasting CF episode be remembered? Will it be remembered as "scientific fiasco" or "scientific triumph"? To answer this question we need at least one reproducible- on-demand demonstration of a nuclear effect resulting from a chemical (atomic) process.

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