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Low-Energy Nuclear Reactions Research: 2008 ACS Update

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Introduction: A science journalist’s view of the field of low-energy nuclear rections (LENRs), historically known as “cold fusion,” is presented. The author has investigated innumerable aspects of this controversial subject, including its strengths and weaknesses. [1-4] He has engaged proponents and opponents alike and provides a balanced understanding and view of the field.

LENR Topics to Be Discussed in This Talk:

- Terminology
- Brief History
- Strengths and Weaknesses of Fusion Claim
- Strengths and Weaknesses of Weak-Interaction Claim

Terminology: The phrase LENR describes the observations in the field of condensed matter nuclear science.

The term “cold fusion” is no longer applicable. One reason is that the term implies that these reactions are a “colder” form of conventional thermonuclear reactions, which they are not. Another reason is that other, nonfusion reactions have been observed in addition to the possible fusion reaction.

LENR includes the effect introduced at the University of Utah in 1989 by Martin

Fleischmann and Stanley Pons – which transmutes deuterium, in the presence of palladium, into heat and helium-4 – as well as heavy-element transmutation research and experiments that show signs of low-level neutron production.

Brief Update on History of Field: The U.S. Department of Energy reviewed the field very early on, within the first few months of the University of Utah announcement. The government's decision not to fund the research was made by advisers to U.S. President George H. W. Bush before the review.

In 2004, in response to a request by several researchers in the field, the Department of Energy took a second look. The department called it a review of LENRs. The reviewers' responses were mixed. The department did not fund any research.

Despite the lack of interest from the Department of Energy, 20 years later, evidence for the reality of new energy-releasing nuclear reactions is plentiful in the relevant literature. A large part of the conflict and confusion surrounding the topic has been the result of some researchers' claims that the LENRs are a new form of fusion.

That argument – about the underlying mechanism or mechanisms responsible for the observed phenomena – remains open. However, the arguments about the validity of excess-heat measurements, nuclear products, emissions and effects are, in this author's opinion, beyond question.

Strengths and Weaknesses of Fusion Claim: The evidence for the production of helium-4 in experiments with deuterium is rigorous. The helium-4 claims have stood for 14 years. Many experiments show the energy released concurrently with the production of helium-4 within the range that is expected from the mass deficit of two deuterons.

A near-quantitative correlation of energy to helium-4 has occurred on at least one occasion. Michael McKubre of SRI International has proposed that the reason the precise quantitative correlation has been observed infrequently is that helium-4 is being retained in the palladium lattice.

McKubre tested the retention idea once and obtained a mass balance close to 24 MeV per helium-4 atom. However, in another experiment, Danielle Gozzi, with the University of Rome, melted the cathode and found no retained helium-4 in the palladium at the detection limit. The helium-4 retention proposal remains speculative.

Several facts contradict the fusion claim or, at a minimum, contradict the association of the phenomena observed in LENR with thermonuclear fusion. They follow:

1. Missing or suppressed gamma
2. Wrong neutron-to-tritium ratios
3. Wrong ^{4}He-to-neutron ratios
4. Missing first branch of thermonuclear fusion
5. Missing second branch of thermonuclear fusion
6. Weak data for 24 MeV energy (wide range of data, incomplete assay)
7. Heavy element transmutations
8. Normal water and hydrogen experiments

Some theorists speculate that a new type of fusion may be occurring. Their models describe a process by which neutrons are captured by a nucleus, and this process is leading to the formation of new elements.

They suggest that this process is a new type of fusion, in the general sense, of two particles coming together to form a new element. This speculation lacks credibility because it attempts to twist the very clear, well-accepted understanding of fusion: a process in which like-charged atomic nuclei overcome the Coulomb barrier (electromagnetic force) and get close enough so that the strong force pulls them together.

Strengths and Weaknesses of Weak-Interaction Claim: An alternative mechanism, relying on the weak interaction, has been proposed to explain the production of helium-4, excess heat with both heavy and light water, heavy-element transmutation and a variety of other phenomena observed in LENR.

Weak interactions, using neutron capture processes, have the advantage of not needing to explain how the Coulomb barrier is overcome at low temperatures. As well, by not claiming a fusion reaction, researchers postulating neutron capture processes do not have to resolve the "three miracles" proposed by John Huizenga of the University of Rochester.

Huizenga's three miracles are:

- the lack of strong neutron emissions
- the mystery of how the Coulomb barrier is penetrated
- the lack of strong emission of gamma or x-rays

One of the weak-interaction theories, proposed by Allan Widom and Lewis Larsen, relies on neutron formation from electrons and protons/deuterons, followed by local neutron absorption and subsequent beta-decay processes.

The authors have shown a relationship between their model and some of George Miley's (University of Illinois) transmutation data. They suggest that their model can explain both the transmutation data of Yasuhiro Iwamura (Mitsubishi Heavy Industries) and energy production from hydrogen and deuterium experiments.

The weak-interaction models are not widely supported in the LENR field; most LENR researchers are skeptical. Outside the LENR field however, the weak-interaction models are showing strong signs of acceptance..

Low levels of neutron emissions, which may be the result of secondary reactions, have been observed throughout the 20-year history of the field – most recently, as published by researchers at the Space and Naval Warfare Systems Center in San Diego, Calif.[5]

References

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