Trapped Neutron Catalyzed Fusion Model with an Adjustable Parameter: A Phenomenological Approach to the Cold Fusion Phenomenon

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The trapped neutron catalyzed fusion (TNCF) model is a phenomenological model[1] which assumes several premises based on the experimental facts obtained in the cold fusion phenomenon (also called LENR). The model uses an adjustable parameter n_n.

Fundamental Premises of the TNCF model

Several fundamental premises of the model are as follows:

(1) Existence of Trapped Neutrons

We assume *a priori* the existence of the quasi-stable trapped thermal neutrons with a density n_n in applicable solids (cold fusion nuclear-active materials). The density n_n in a sample is an adjustable parameter which will be determined by an experimental data set using the common supplementary premises.

(2) Reaction of the Trapped Neutron with Nuclei in the Material, and Production of Excess Energy

The trapped thermal neutron is assumed to react with another nucleus in the cold fusion material. The reactions are assumed to be the same as those that occur in free space. If a fusion reaction occurs between a trapped thermal neutron and one of lattice nuclei ${}^{A}_{Z}X$ with a nucleon number A and a proton number Z, then excess energy Q and nuclear products are generated:

$$n + {}^{A}_{Z}X = {}^{A+1}_{Z}X^{*} = {}^{A+1-b}_{Z-a}X' + {}^{b}_{a}X'' + Q, \qquad (1)$$

The number of reactions (per unit time) between trapped neutrons and a nucleus ${}^{A}_{Z}X$ may be calculated by the same formula as the usual collision process in free space:

$$P_f = 0.35\, n_n\, v_n\, nx V \sigma_n X, \qquad (2)$$

where $0.35\, n_n\, v_n$ is the flow density of the trapped neutrons per unit area and time, nx is the density of the nucleus ${}^{A}_{Z}X$, V is the volume where the reaction occurs and $\sigma_n X$ is the cross section of the reaction.

(3) Reactions Producing Several New Particles According to Assumed Reactions

With Reaction 1 we can describe several reactions relevant with nuclear products observed in cold fusion phenomena:

$$n + d = t\ (6.98\ \text{keV}) + \gamma\ (6.25\ \text{MeV}), \qquad (3)$$
$$n + {}^{6}_{3}\text{Li} = {}^{4}_{2}\text{He}\ (2.1\ \text{MeV}) + t\ (2.7\ \text{MeV}), \qquad (4)$$
$$t\ (\varepsilon) + d = {}^{4}_{2}\text{He}\ (3.5\ \text{MeV}) + n\ (14.1\ \text{MeV}), \qquad (5)$$
$$n\ (14.1\ \text{MeV}) + d = n' + d', \qquad (6)$$

(4) Emission of Phonons in Cold Fusion Materials Instead of a Photon in Free Space

In Reaction 3, there is a photon described by γ which is expected in a free space reaction. In the cold fusion materials, we assume that the second term on the right of Reaction 3 should be read as ϕ expressing phonons observed as excess energy in the cold fusion phenomenon.

Remarkable Results Obtained by the TNCF Model

The model is applicable to both protium and deuterium systems where we have observed the cold fusion phenomenon from emission of light nuclear particles to nuclear transmutations resulting in production of heavy nuclei.

One of the most interesting experimental results explained by the TNCF model is the ratios of numbers N_x's of events X's observed simultaneously. Determining the parameter n_n by the data of the number N_x of an event X, we can calculate the number N_y of another event Y using the model and compare the theoretical ratio $(N_x/N_y)_{\text{th}}$ thus calculated with the experimental value $(N_x/N_y)_{\text{ex}}$. We have obtained fairly good coincidence of these values to within a factor of about three, as expressed by the following relation:

$$(N_x/N_y)_{\text{th}} = \alpha (N_x/N_y)_{\text{ex}}$$

with $\alpha \sim 3$.

One of the statistical laws discovered in the experimental data is the $1/f$ dependence of the frequency on the intensity of the excess energy production. This fact suggests that the cold fusion phenomenon is a complex phenomenon, of the type that has been investigated extensively in nonlinear dynamics. Therefore, we should not expect quantitative reproducibility for events in the cold fusion phenomenon, but rather qualitative or statistical reproducibility.

Predictions of the TNCF Model and Suggestions for Future Experiments

The successful explanation of many events in the cold fusion phenomenon by the TNCF model predict that the necessary conditions for the nuclear reactions in cold fusion materials are formed by complex, statistical atomic processes and therefore events in the cold fusion phenomenon have only qualitative reproducibility but not quantitative.

Investigation of the physics of the cold fusion phenomenon is very important to explore application of this interesting research field to many objects from nuclear transmutation to energy sources.

Recognizing these characteristics of the cold fusion phenomenon described above, we would like to ask researchers

doing experiments to pay attention to the following points:

(1) To measure as many observables simultaneously as possible in an experiment, to determine a mechanism resulting in these results.
(2) To take care of temporal variation of events if they reveal a feature of complexity.
(3) To determine the statistical nature of events, and to pay close attention to those events, even if those events lack quantitative reproducibility.

Reference

1. Kozima, H. 2006. *The Science of the Cold Fusion Phenomenon*, Elsevier Science.

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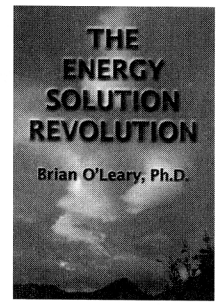

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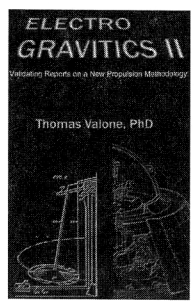

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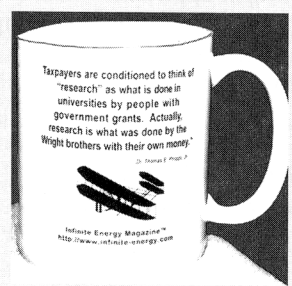

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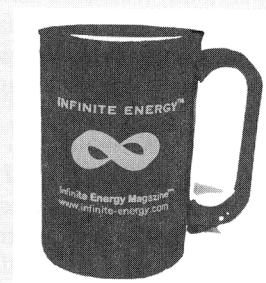

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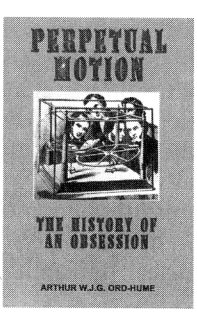

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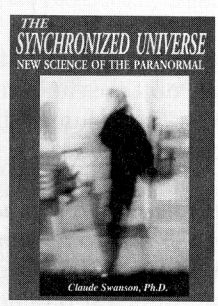

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