Lawson Criterion Made Obsolete by Cold Fusion through the Double Screening Process

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Abstract:

It is shown that the same phenomenon has been observed in Cold Fusion and also in another rather different experiments. The necessity to take into account the electron participation in nuclear fusion process in dense media is ensuing from this result. It implies that the fusion reaction rate, necessary for obtaining the Lawson criterion in the thermonuclear case, is not any valid in those experiments: so a new formula is proposed.

1. Introduction: Correlation between experiments

Nuclear fusion reaction counting data from diverse tentative fusion experiments have been plotted in function of deuteron energy E in logarithmic scale (Figure 1). Those experiments were of three kinds: the D^2O cluster collision experiments, the transitory flow of current pattern in deuterated media, and the so called cold fusion experiments [1]. It turned out that those experiments were non-thermonuclear origin and that the mean square method applied to the experiment representative points, could lead to a fit with a straight line whose slope was bounded between 1.5 and 2.

This correlation suggested that there could be a common cause of the fusion reaction production in very different experiments

The hypothesis which was been made consisted of taking into account the role of all plasma constituents, particularly the electrons, whereas the thermonuclear hypothesis takes only into account the ion existence.[2]

FRONTIERS OF COLD FUSION

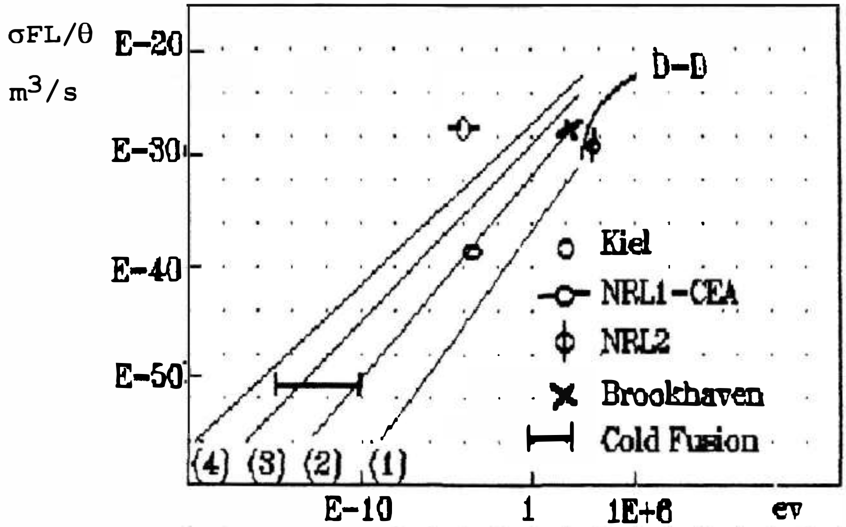

Figure 1. Fusion production factor $\sigma FL/\theta$ in function of deuteron energy in logarithmic scale. The number of electrons per cloud is respectively: (1) 342, (2) 1350, (3) 3374, (4) 5.10^4. The arc D-D corresponds to the thermonuclear case.

2. Double screening process.

There are two causes of modifying the Coulomb barrier between two colliding deuterons. Firstly the cloud of moving electrons, with their great mobility, from the nearby environment towards the positive potential accident created by the two colliding deuterons. Secondly a change of reference potential V_p at the colliding place due to the environmental electron depopulation. The whole phenomenon can be called "Double Screening", inspite the first effect is less important than the second one. This reasoning leads to an effective expression in function of radius r, outside the nuclear well, which has the form,

$$V = f(e/r - V_p) \qquad (1)$$

This potential is close to the one proposed phenomenologically by many authors [2].

$$V = (e^2/4\varepsilon_0)[(1/r) - (1/R)] \ , \ r_1 < r < R \qquad (2)$$

For calculating the barrier transmission factor F, the non relativistic Schrödinger equation is useful. One can drop the L-term, as the wavelength of partial amplitudes is large [2].

One has to take into account the real useful parameters in this process: the nuclear reaction rate R, the nuclear cross section σ, the whole barrier crossing duration θ, the barrier width L, the transmission barrier factor F, the number n of particles which can be involved in a nuclear reaction. Using an improved dimensional analysis method [2], one gets the following formula:

$$R = (n^2/4)\ \sigma F L/\theta \tag{3}$$

It replaces the customary expression, valid only in the thermonuclear hypothesis and which imply the Lawson criterion:

$$R = (n^2/4)\ \langle\sigma v\rangle \tag{4}$$

3. Results of calculations.

The results of the barrier transmission factor calculations, give a straight line in the log R diagramm vs log E, for a constant number of electrons contributing to the Double Screening (Figure 1). The slope of those straight lines is close to the slope of the straight regression line, deduced from the experimental points. The most probable number of those electrons is in the range of 10^3 to 2 10^3.

Moreover this number is in agreement with simple ion distribution considerations in dense media, this point of view consisting of assuming that the 3D spatial deuteron distribution obeys Poisson's law [2].

The results of those calculations are also in agreement with several experimental results, the most striking being the Brookhaven results of D^2O colliding clusters [3]. The number of nuclear fusion reactions has a maximum in function of the D^2O molecule number in the cluster (Figure 2). For a D^2O number inferior to the one of maximum there is one unique deuteron collision center. The maximum corresponds to the turning up of two deuteron collision points . Those two collision centers are competitor for attracting the environmental electrons.

A D^2O collision experiment performed with a greater number of D^2O molecules in the cluster would probably give another maximum counting rate followed by a decrease, corresponding to the turning up of three deuteron collision centers.

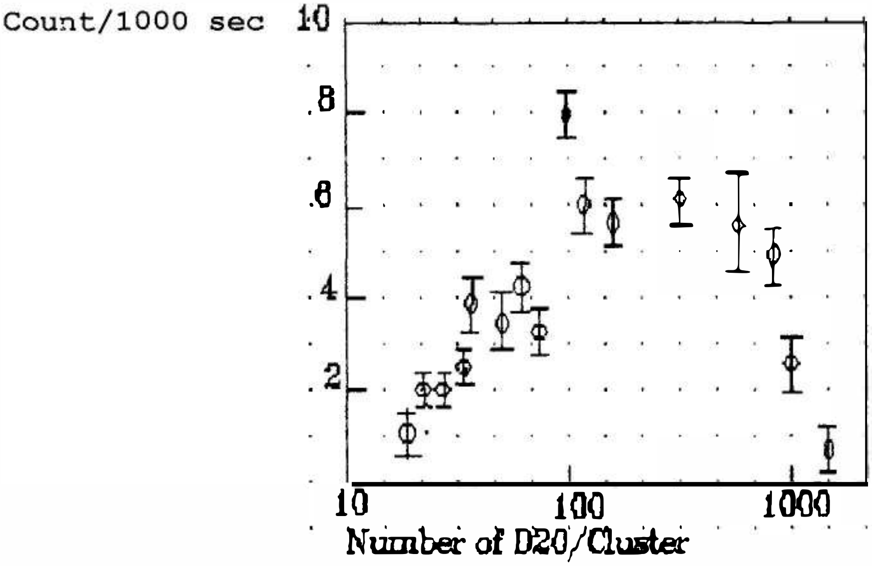

Figure 2. From [3]. The proton yield dependence on the cluster size.is depicted for 300 kev clusters.

4. Conclusions

Electrons play a fundamental role in a nuclear process. An experiment performed by M.Fallavier et Al [4] , with pure deuteron clusters has not given any fusion reaction. According the double screening model, clusters must be rich in electrons for sustaining fusion reactions. It builds up the conjecture which consist to suppose, as made J.Schwinger [5], that the D(D,^{4}He)gamma reaction becomes probable. So it could account for the mysterious excess heat production, given that ^{4}He nuclei have a very short range in dense media, and can so produce gammas and heat.

6. References

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