IFM - 10/89
May 1989

Three body effects and neutron suppression in cold fusion

R. Vilela Mendes
GTAE - Grupo Teórico de Altas Energias
Av. Gama Pinto, 2 P - 1699 Lisboa Codex, Portugal

ABSTRACT

It is pointed out that, when low energy 3-body scattering processes are responsible for cold fusion, the prefered fusion channel is such as to lead to heavy suppression of neutron production.

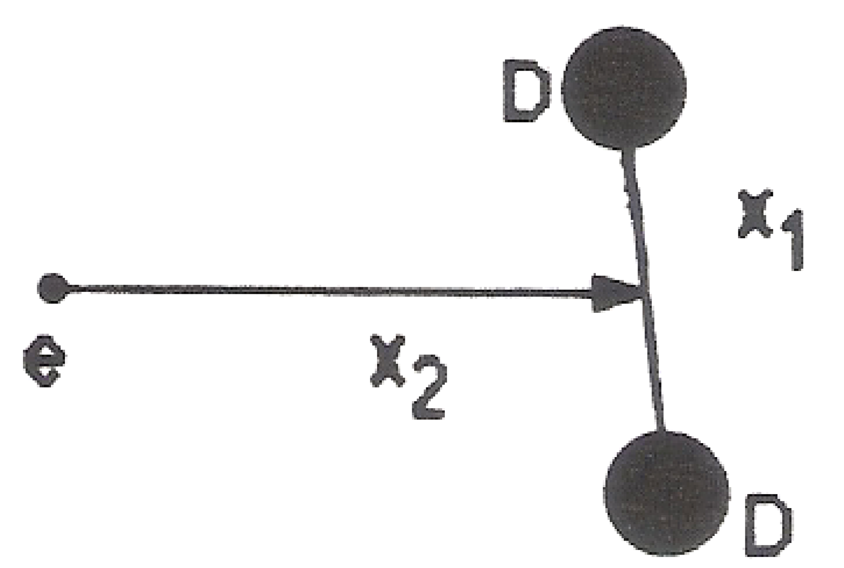
Three-body scattering processes at low energy may play an important role in cold fusion. A lower bound estimate based on phase space uniformity assumptions suggests that indeed such processes might play a role under certain conditions discussed in Ref.[1]. The n-body complexity of the underlying problem implies however that any realistic estimate requires a detailed computation which is now in progress[2].

Assuming that these low energy 3-body processes take place , I discuss the nature of the fusion channels, exploring in particular the possibility that these processes lead to a smaller rate of neutron production than the approximate 50-50 balance expected from the D+D $\rightarrow$ T+ p and D+D $\rightarrow$ ^{3}He + n two body processes.

The low energy condition and the requirement that the three particles be simultaneously near the origin with high probability imply that, for the fusion processes that actually take place through the 3-body channel, the Faddeev amplitude

$$\phi(\vec{x}_1,\vec{x}_2) = \sum_{\alpha\ell_1\ell_2 LS} d_{\alpha\ell_1\ell_2 LS}(x_1,x_2)\ \{[Y_{\ell_1}(\hat{x}_1)\, Y_{\ell_2}(\hat{x}_2)]_L\ \chi^S_\sigma(123)\}_J$$

is dominated by the $\ell_1=\ell_2=0$ contribution.



This forces the corresponding compound DD state to have positive parity and, from the known spectrum[3] of ^4He excited states, the 20.1 (0^+) state is selected as the most likely outgoing compound nucleus. Direct formation of ^4He in the ground state is less probable for it would imply the transfer to the electron, by electromagnetic interactions alone, of a recoil energy on the scale of the nuclear interaction.

When the $^4He^*(20.1)$ excited compound nucleus moves away from the 3-body interaction region the only decaying channel open in its center of mass is T+p . The prefered channel is therefore

$$D + e + D \rightarrow {}^4He^*(20.1) + e \qquad (1)$$
$$\qquad\qquad\qquad \llcorner\!\!\rightarrow T + p$$

leading to a natural suppression of neutron emission.

In conclusion : Whenever low energy 3-body scattering processes of the type described in Ref.[1] play an important role, the prefered fusion channel is the one in Eq.(1) and neutron production will be heavily suppressed.

REFERENCES

[1] S. M. Eleutério, R. Vilela Mendes ; "Three body effects in cold fusion" , preprint IFM-9/89.

[2] S. M. Eleutério, R. Vilela Mendes ; work in progress.

[3] S. Fiarman, W. E. Meyerhof ; Nucl. Phys. A206, 1 (1973).