Electron Catalyzed Fusion

Horace Heffner   March 2001

(Some more recent updates included as well)

Suppose you have three charges, two deutrium nucleii (+) and and electron (-), all in a line in the x axis separated by (an initial) distance of 10^-11 m:

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             d1                   d2
   (+)               (-)                 (+)

   v1->              v2->
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What is the initial net force on each particle? The force between the left deuterium nucleus and the electron and is given by

$$F1 = q^2/(4 \text{ Pi } e0 \ r^2) = 8.98 \text{ N}$$

and is to the right towards the electron. The force the two deuterium nucleii is repulsive and is 1/4 the magnitude of the force between the deuterium and the electron because the distance is doubled, i.e. d1 + d2 = 2 d1. So the net force on the left deuteron is 3/4 * 8.98 N = 6.74 N and is to the right. Similarly, the net force on the right deuteron is 6.74 N and is to the left. The net force on the electron balances out to zero.

Further assume the electron has a sufficient velocity that its deBroglie wavelength is unimportant, i.e. that it is a point charge for the sake of this discussion. Further the leftmost deuteron has a velocity v1 relative to the rightmost deuteron and which is directed toward it, and the electron has velocity:

$$v2 = v1/2$$

What happens next? What direction is the initial acceleration provided by the net force on the rightmost deuteron? What direction is the initial acceleration provided by the net force on the leftmost deuteron?

If we look at the problem in the reference frame of the electron then the outcome is straightforward. The two deuterons are attracted to the electron equally thus accelerate toward it at the same velocity at every instant. The force is maintained until the wavelengths of the particles overlap and the force diminishes.

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Suppose two H nucleii are maintained at a constant distance by the presence of the [orbital] electon waveforms already present. The potential of the bond between these electrons and the nucleii is small, less than 30 eV. An impinging 3 keV electron can blow the orbital electron waveforms TOWARD the deuteron pair, thus INCREASING the NET CHARGE between the two deuterons, and thereby even further increasing the attraction between the two deuterons.

A hydrogen atom in D2 has a radius of about 0.32 A, so for this reason it is anticipated the impinging electron's de Broglie wavelength must be less than .32 A. At a larger wavelength, i.e. less energy, dipole moment shielding would occur, preventing a close approach to the nucleus by the electron. At .32 A, and in absence of a magnetic field, the hypothesized effects would begin to be noticed, but a smaller wavelength, e.g. half that size, should produce more significant effects.

Now: p=h/L, where p=mv so: mv=h/L, v*(9.11E-31kg)=(6.626E-34 joule*sec)/ (0.32E-10 m), v=2.273E7m/sec. Looking at energy, E= .5mv^2= (.5)(9.11E-31kg)(2.27E7)^2, E=2.353E-16joule/ (1.602 E-19 joule/eV)=1470 eV. So a minimal energy electron to initiate the process should be about 1470 eV, quite a bit to get inside a lattice! This can not be accomplished by temperature alone because 1eV=1.15E4 deg K, so the temperature would be 1470*1.16E4=17,000,000 deg K. Further, making the suggested process likely requires limiting the degrees of freedom. It is only likely to happen in a lattice where the nucleii are all aligned neatly in a row and the impinging electrons are already channelled or directed by the aligment of the lattice face holes. It is not as likely to happen in a plasma. Also, due to the comaparatively large wavelength of the electron, the process can not proceed to completion, i.e. to a completely fused nuclear pair, but it can proceed to bring the nuclei to sufficiently less than 10^-11 m to permit tunneling. The electron's initial wavelength is reduced as it approaches the first deuteron, due to falling into its Coulomb well.

One interesting thing about this mechanism is that an electron might end up in a new nucleus at a low energy yet not bound into the nucleus by a weak reaction. Perhaps this sets up a radiation process, due to the electron's radiation, whereby the bond kinetic energy of the excited nucleus is transferred to the lattice over a (relatively) long time by low energy radiation. Ultimately, if the elecron stays in the nucleus long enough, the electron should be involved in a weak force reaction. Since the electron did not gain substantial kinetic energy in the suggested fusion process, perhaps the characteristic electron capture gamma is not seen.

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If the electron sheilded deuteron reaction occurs, it may be of the form:

D+ + D+ + e- -> 4He++ + e-*

or

D+ + D+ + e- -> T+ + H+* + e-*

or maybe

D+ + D+ + e- -> 4H+ -> 3H+ + n

Most of the kinetic energy of the reaction may go temporarily to the electron e-*, which requires about 1 MeV to escape the Coulomb well, and which may dump excess energy into the lattice before escaping the Coulomb well or forming a neutron.

"Electron catalyzed fusion" may be a good term for the process outlined above. The process is different from electron shielding and muon catalyzed fusion to the extent that a medium energy electron is required, having energy more than an order of magnitude above chemical bond energies.

Tunneling is necessary to account for the hot fusion rate at a given temperature. It also accounts for the operation of the Josephson Junction and the tunnel diode. Regardless of the "true" nature or explanation for the effect, tunneling exists and is strongly tied to the fusion process. The coulomb barrier can be jumped, and the distance (d1 + d2 above) at which it is likely to be jumped is comparatively large, i.e. it is a separation that can be [jumped] provided a mere ~20 keV initial deuteron energy. The question of how CF overcomes the Coulomb barrier might be answered by the illustrated process, or by lower energy electron screening, as proposed early on by Peter Hagelstein and others.

One of the significant problems of maintaining a screen at low energies is the fact that an electron is not a point charge, but is wavelike. It is suggested here that high energies reduce the electron wavelength and at some electron energy, i.e. at around 2-3 keV, the suggested electron catalysis shielding effect begins to come into play. Pre-alignment of the deuterons all in a row in the lattice may assist in greatly raising the probability of the effect from a single electron, and help align the electron velocity with the lattice, and even help start a kind of e-fusion-e-fusion chain reaction. There is a source of seed electrons in the form of secondary electrons from cosmic rays.

It is of further interest that electron catalyzed fusion is more likely to occur in a high electron flux high energy environment, than a low flux environment, due to the increased incidence of, a high replacement rate of, the small waveform electrons between nuclei. This fact may account for various regimes (e.g. Kamada et al experiments) where fusion rates are a function of electron flux, in addition to energy.

Electron catalyzed fusion should not produce characteristic high energy signatures. The electron arrives in the fused nucleus without gaining kinetic energy by “falling into” the nucleus. An unbound electron in the nucleus represents an oscillating dipole, and thus radiates. Perhaps the nature of the radiation from the reduced energy electron is such that it couples with adjacent nuclei and thereby dumps the energy very slowly (compared to a MeV magnitude gamma release). In fact, if the catalytic electron is expelled from the new fused nucleus, that expulsion drains MeV levels of energy from the nucleus, eliminating the possibility of MeV level gamma or beta radiation. The nuclear energetics are completely changed, and there is no reason to expect standard branching ratios.

Electon catalyzed fusion might be facilitated by doping a loaded matrix with beta producers like Ce or tritium, or by bombardment with x-rays of sufficient energy.