INTERNATIONAL ATOMIC ENERGY AGENCY
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
I.C.T.P., P.O. BOX 586, 34100 TRIESTE, ITALY, CABLE: CENTRATOM TRIESTE

H4-SMR 393/46

SPRING COLLEGE ON PLASMA PHYSICS

15 May - 9 June 1989

COLD FUSION - A MODERN STORY

S. Mahajan

University of Texas at Austin
Institute for Fusion Studies
Tx 78712
Austin
U. S. A.

Cold Fusion ↔ A Modern story.

A Star is Born

Pons – Fleischmann declared sometimes in the second week of March, 1989 that one of the dreams of mankind is about to be fullfilled.

Fusion of D+D in an eletrochemical cell. ⇒ An Exothermic process with $Q \geq 4 \sim 10$

An electrolytic cell with Palladium and Platinum electrodes.

⇒ This stunning news with enormous scientific, and economic consequences hit the world through all the best known Scientific journals of the World; The New York times, The Wall street journal . . – . – – – – .

In a few days ↔ A Scientific Preprint appeared

Let ~~me~~ Summarize its contents:

For a 100 years → Ability of Palladium to absorb enormous amts. of hydrogen. Since extended to Deuterium & Tritium.

In a series of steps, D_2 is discharged from the alkaline solutions of Heavy Water D_2O, and can be electrochemically driven into the Pd lattice.

(#1) Hydrogen is ionized and is [redacted] highly mobile.

Results

[99.5% D_2O, 0.5 H_2O]

Calorimetric Measurements:

| Pd → Cathode
| Pt → anode

Sheet Cathode 2mm × 8cm^2. (Pd) at low currents }

Results of these in the table:

⇒ Large Excess Heat was observed $Q \gtrsim 4$, L. Angeles meeting $Q \sim 10$-40

\# γ-Rays : signature of Neutron-Production

$$n + p \longrightarrow {}^2D + \gamma \; (2.5\,\text{MeV})$$

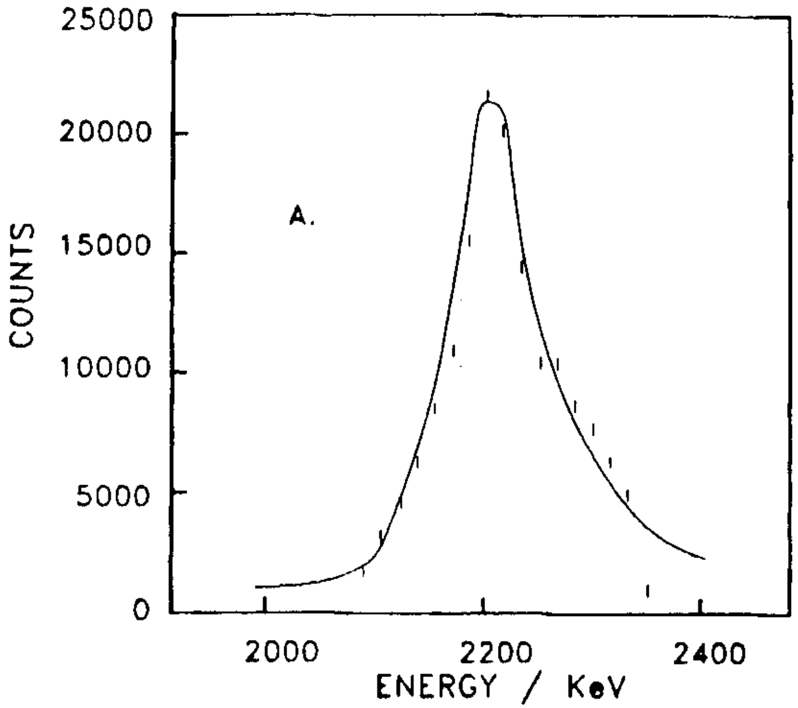
(2.45 MeV)

A mag. transition → NaI crystal

[Graph shown on local UTAH TV]

Neutron flux ~ ~ 2.4×10^4 (estimated)

~ 3 times (background)



\# Tritium Production: → } low levels

He^3 .. → }

He^4 → yes → (?)

More on Heating:-

(i) Heating is a bulk phenomenon

(ii) Amt of heat generated ~ 10 Watts/cm^3

($\gtrsim$ 120 hours) Heat ~ 4 MJ/cm^3.

⇒ ^{6}It is inconceivable that this could be due to anything but nuclear

TABLE 1. Generation of excess enthalpy in Pd-cathodes as a function of current density and electrode size.

electrode type	dimensions	current density /mA cm−2	excess rate of heating / watt cm−3	excess specific rate of heating/watt cm−3	current density /mA cm−2	excess rate of Heating/watt	excess specific rate of Heating/watt cm−3	current density * /mA cm−2	excess rate of * Heating/watt	excess specific rate of Heating/watt cm−3
Rods	0.1x10cm	8	.0075	.095	64	.079	1.01	512	.654	8.33
	0.2x10cm	8	.036	.115	64	.493	1.57	512	3.02	9.61
	0.4x10cm	8	.153	.122	64	1.751	1.39	512	26.8	21.4
Sheet	0.2x8x8cm	0.8	.153	0	1.2	.027	.0021	1.6	.079	.0061
Cube	1x1x1cm	125	←WARNING! IGNITION? see text*		250					

*Measured on electrodes of length 1.25cm and rescaled to 10cm.

TABLE 2. Generation of excess enthalpy in Pd rod cathodes expressed as a percentage of breakeven values.

dimensions	current density /mA cm−2	excess heating * /% of breakeven	excess heating ** /% of breakeven	excess heating *** /% of breakeven	current density /mA cm−2	excess heating * /% of breakeven	excess heating ** /% of breakeven	excess heating *** /% of breakeven	current density /mA cm−2	excess heating * /% of breakeven	excess heating ** /% of breakeven	excess heating *** /% of breakeven
0.1x10cm	8	23	12	80	64	19	11	79	512	6	5	81
0.2x10cm	8	62	27	286	64	46	29	247	512	14	11	189
0.4x10cm	8	111	53	1224	64	66	45	438	512	59	48	839

breakeven based on Joule heat supplied to cell and
de reaction $4OD^- \to 2D_2O + O_2 + 4e$
f breakeven based on total energy supplied to cell
anode reaction $4OD^- \to 2D_2O + O_2 + 4e$
of breakeven based on total energy supplied to cell
for an electrode reaction $D_2 + 2OD^- \to 2D_2O + 4e$
a cell potential of 0.5V.

's based on $^2D + ^2D$ reactions, i.e. no projection to
T reactions

(iii) Jt $D_2T \to DTO, T_2O, D_2O$ mixtures

$Q \sim 10^3 - 10^4$.

Cathode fused (1554°C), ⇒ general destruction of the cell resulted:

⇒ Ends with a Discussion:

* We raise more questions than we have provided the answer for — True

* Generation of neutron & Tritum itself is a very surprising result — True

* Necessary to consider the quantom mechanics of electrons and deuterons in such host lattices — True

* Is it possible to achieve a fusion rate of of 10^{-19} s^{-1} for the reactions

$D + D \to T + H$

$D + D \to He^3 + n$

at typical energies of ~1eV ??

and finally.

6 The bulk of the energy <u>is due to an</u> hitherto unknown nuclear process or processes (presumably again due to clusters of deuterons)?

		Conv. Fusion
Confinement etc :	10^6 years	1 sec
	$T \sim 1eV$	10 keV
	$n \sim 10^{23}$	$n \sim 10^{14} - 10^{15}$

and really finally they warned all the experimentalists to be careful because they will be playing with fire. In fact Ignition may result.

Pretty soon lots of other people claimed that they also see ; it wasn't always clear what is that they ~~saw~~ really see

1) Georgia Tech → Neutrons (retracted)

Electrolytic 2) Stanford → Lot of Heat (retracted)

3) Texas A&M → Heat and later neutrons *.

4) M.I.T → see nothing, hear nothing

5) CALTECH → - - - - - - - - -

6) FRASCATI → Non electrolytic . . .

THE NEWS COMES TO US

I.F.S at Univ. of Texas : Largest (?) Fusion Theory Group in the states.

⇒ Rush to the Library and grab nuclear phys. books ; we must have a theory if they have an experiment - -

Comparatively Modest but still very interesting Claims of Jones, Rafelski . . . . .

Theorists Get Active

' A good theorist can explain any thing '

Moses – Deuteronomy III.

Plausibility theories immediately came forward:

Pons – Fle… are probably right

After all if the D-D could get within to a tenth or less of an $\AA$, these enormous densities could give you what you want.

A Simple Review: – Semi-Serious Theories:

Crossection Calculations in Nuclear Physics are often difficult; but a combination of theory – expt. has been very successful in predicting crossections: –

Flowers & Mandl: – (1950)

D + D system

To have appropriate spatial Wave Functions:

To construct the spatial wave functions, we have proceed as follows: –

$D_1 \sim n_1 p_1 \qquad \sim e^{-\kappa(\underset{\sim}{r_1} - \underset{\sim}{r_3})^2}$

$D_2 \sim n_2 p_2 \qquad \sim e^{-\kappa(\underset{\sim}{r_2} - \underset{\sim}{r_4})^2}$

$(\kappa^{-1})^{1/2} \sim$ denotes the size of the deuteron

Similarly we can construct He^4 wave function

$[\ D + D \to He^4 + \gamma + (24\ MeV)\ ]$

~~Centre of masses~~

(1) should be near (2)

(2) " " " (3)

(3) " " " (4)

$$\Rightarrow e^{-\lambda[(\underset{\sim}{r_1}-\underset{\sim}{r_2})^2+(\underset{\sim}{r_2}-\underset{\sim}{r_3})^2+(\underset{\sim}{r_3}-\underset{\sim}{r_4})^2]}$$

$(\lambda^{-1})^{1/2} \to$ size of He^4 . .

Deuteron is loosely bound $a_D \sim 10^{-12}$ cm

Helium " tightly bound $a_{He} \sim 10^{-13}$ cm

[κ, λ . . are the form factors, and are often adjusted using exptal data, A crucial part of the calculation is the relative wave function of the two charged Deuterons: – φ_{rel}

$$D + D \rightarrow He^4 + \gamma$$

$$M = \int d\tau \, e^{-x(r_1 - r_2)^2 - x(r_3 - r_4)^2} \; T_{op} \; e^{-\lambda(\cdots)} \varphi_{rel}$$

→ Transition operator

→ Quadrupole moment of D-D system

⇒ strong interaction operator → $(D + D \rightarrow He^3 + n)$

⇒ Electrical dipole

$p + d \rightarrow He^3 + \gamma$

$n + p \rightarrow D + \gamma$

φ_{rel} is what one must understand (φ).

D-D Wave Function (Coulomb)

D ~ 2 GeV E <<< 2 GeV

Non relativistic approach is O.K

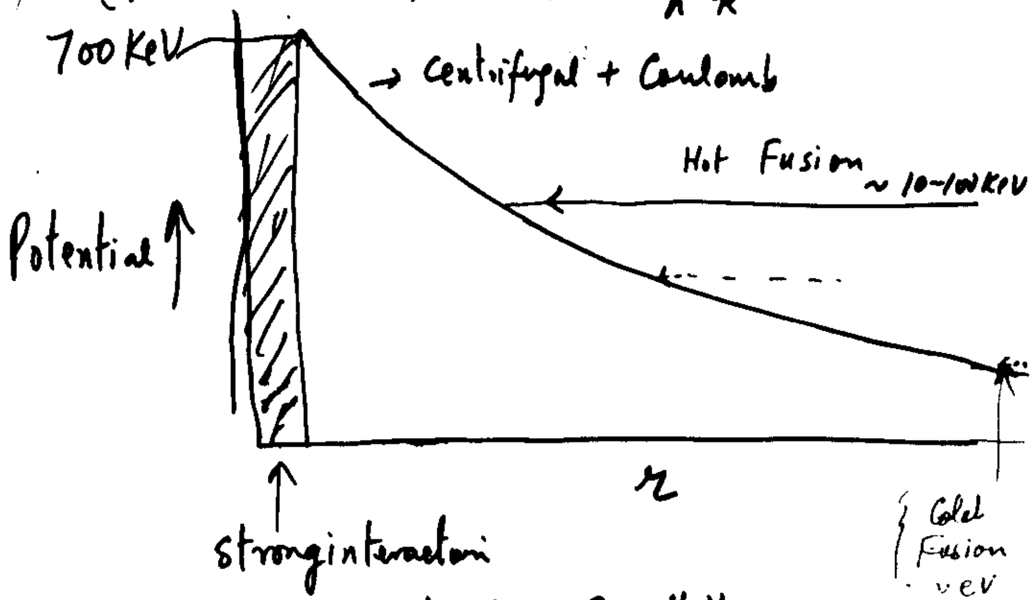
$$-\frac{\hbar^2}{2\mu r^2}\frac{d}{dr} r^2 \frac{d\varphi}{dr} + \frac{\hbar^2}{2\mu r^2} l(l+1)\varphi + V(r)\varphi = E\varphi$$

$V(r) = \frac{e^2}{r}$ unscreened Coulomb interaction

⇒

$$\varphi = \frac{C}{r} M_{\delta,\mu}(2ikr)$$

$k = \left(\frac{2mE}{\hbar^2}\right)^{1/2}$ $\delta = i\eta$, $\eta = \frac{\mu e^2}{\hbar^2 k}$, $\mu = l + \frac{1}{2}$



[illegible] Nuclear Physics E ~ MeV, you [illegible]

(1Pa)

Using the appropriate formulas, and taking the free particle wave ~~wave~~ function

$$\left(\frac{\pi}{2kr}\right)^{1/2} J_{l+\frac{1}{2}}(kr) \ldots$$

one calculates σ, and then determines the unknown κ, λ ....

by comparing with experiments: —

Determining the form factors:

Scattering experiments at several MeVs

But low energies, free particle wave functions are no good.

DEUTERON CAPTURE BY DEUTERONS

W. DEL BIANCO and J. M. POUTISSOU
Laboratoire de Physique Nucléaire, Université de Montréal, Montréal, Québec, Canada*

Received 14 April 1969

The $D(d,\gamma)^4He$ differential cross section at $\theta = 130^0$ has been measured over the deuteron energy range from 4 to 10 MeV with a 12.7 cm by 15.2 cm NaI crystal enclosed in a Čerenkov anticoincidence shield. The differential cross section increases from $d\sigma/d\omega = (6.8 \pm 3.1) \times 10^{-33}$ cm^2/sr to $(16.5 \pm 6.8) \times 10^{-33}$ cm^2/sr at 4 and 10 MeV, respectively.

High-energy γ rays are a convenient tool to test the wave functions of the α particle. The $^4He(\gamma,p)^3H$ reaction and its inverse have been measured extensively but there are little experimental data for the $^4He(\gamma,d)D$ reaction. The experimental results for the latter reaction and its inverse have been summarized by Meyerhof and Tombrello [1].

In this experiment we measured the $D(d,\gamma)^4He$ reaction from 4 to 10 MeV deuteron energy.

The deuteron beam from the Université de Montréal Tandem accelerator was used with currents from 0.6 to 1.8 μA. The beam after magnetic analysis and collimation by tantalum diaphragms was allowed through a double-window gas target and came to rest under vacuum on a Ta disc at approximately 80 cm from the target.

The capture γ rays were detected with a 12.7 cm diameter by 15.2 cm long NaI crystal, its axis forming a 130° angle with the direction of the deuteron beam. The NaI crystal was collimated, enclosed in a Čerenkov anticoincidence shield to reduce the cosmic ray background [2] and surrounded by a 10 cm thick lead and 30 cm thick paraffin layer to minimize background radiation [3,4].

The 130° differential capture cross section $d\sigma/d\omega$ is plotted in fig. 1 after correction for absorption in the gas chamber wall and in the paraffin between the target and the detector. The deuteron beam energy refers to the energy at the center of the gas target and the error on the cross section corresponds to the statistical error on the γ-ray yield only. About 30% over the entire deuteron energy range. Other sources of error, estimated to be 5.5%, do not include the uncertainty in the calibration of the photon monitor (15%) and in the γ-ray absorption in the paraffin between gas target and detector (8%).

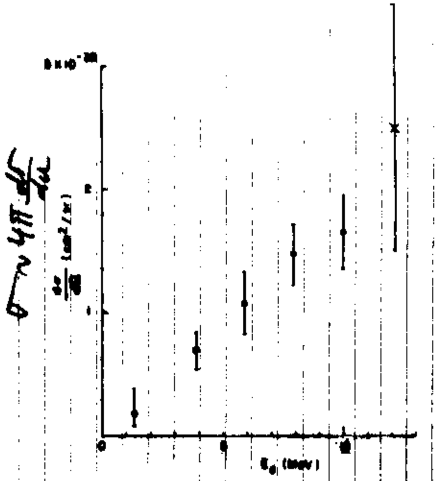


Fig. 1. The 130° differential cross section of the $D(d,\gamma)^4He$ reaction. Data represent the results of this experiment. Points at E_d = 1.25 MeV and E_d = 12.1 MeV are those of [illegible] [5] et al. and Meyerhof et al. [6].

The cross section at E_d = 12.1 MeV was obtained from Meyerhof's $^4He(\gamma,d)$ cross section [6] at E_γ = 20 MeV by means of the principle of detailed balance and by assuming an angular dependence of the differential cross section in the

* Research supported by a Grant from the National Research Council of Canada.

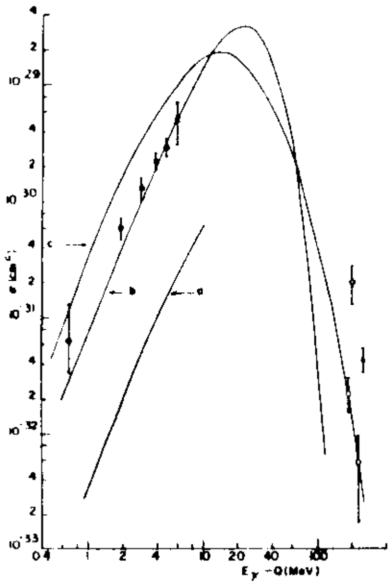


Fig. 2 Total cross sections for ^{4}He(γ,d)D. Comparison of experimental results and theoretical curves. ⊕ - Zurmuehle et al. ● - present experiment × - Meyerhof et al. ○ - Asbury and Loeffler. [] - Akimov et al. ▲ - Poirier and Pripstein. Curve a - Delves Curve b - Flowers and Mandl. Curve c - Asbury and Loeffler.

form of $\sin^2\theta \cos^2\theta$, as to be expected for a $^1S_0 \rightarrow {}^1D_2$ transition [1].

The experimental results of ref. 1 as well as those of this experiment were transformed, where necessary, to determine the total ^{4}He(γ,d)D cross section shown in fig. 2. On the same figure we have plotted the theoretical curves of Delves [7], Flowers and Mandl [8], and Asbury and Loeffler [9], curves a, b and c, respectively. Delves cross section, calculated by taking the ground state of the α particle as a superposition of three cluster states (^{3}He, n), (T, p) and (D, D), is almost two orders of magnitude too small. The failure of this theory, as already remarked by Zurmuehle [5], is possibly a consequence of the inapplicability of the cluster model to the ground state of the α particle. The curves of Flowers and Mandl and of Asbury and Loeffler were calculated from Gaussian and exponential wave functions, respectively, for the ground state of the α particle.

The cross section of Flowers and Mandl is in better agreement with the experimental points at low energies*, but it decreases too rapidly at high energies. In addition the wave function employed by these authors does not give the correct value for the mean square radius of the α particle [1] and yields the maximum cross section for the ^{4}He(γ,p)^{3}H reaction at too high a proton energy [12].

* It should be remarked, however, that Zurmuehle's D(d,γ)^{4}He cross section at E_d = 1.35 MeV was obtained from a thick target and represents an average value between 0 and 1.35 MeV. Thus the (γ,d) cross section at $E_\gamma - Q$ = 0.68 MeV could be larger than indicated in fig. 2.

References

1 W. E. Meyerhof and T. A. Tombrello, Nucl. Phys. A109 (1968) 1.
2. W. Del Bianco and F. Lemire, Nucl. Instr. and Meth. 61 (1968) 229
3. J. M. Poutissou, Master's Thesis (unpublished) Université de Montréal (1968)
4. W. Del Bianco and W. E. Stephens, Phys. Rev. 126 (1962) 709.
5. R. W. Zurmuehle, W. E. Stephens and H. H. Staub, Phys. Rev. 132 (1963) 751.
6. W. E. Meyerhof, W. Feldman and S. Gilbert, Bull. Am. Phys. Soc. 13 (1968) 564.
7. L. M. Delves, Australian J. Phys. 15 (1962) 59
8. B. H. Flowers and F. Mandl, Proc. Roy. Soc. 206 (1951) 131.
9. J. C. Asbury and F. J. Loeffler, Phys. Rev. 137B (1965) 1214.
10. K. Akimov, O. V. Savchenko and L. M. Soroko, Zh. Eksp. Teor. Fiz. 41 (1961) 708; JETP 14 (1962) 512.
11. J. A. Poirier and M. Pripstein, Phys. Rev. 130 (1963) 1171.
12. B. H. Bransden, A. C. Douglas and H. H. Robertson, Phil. Mag. 2 (1957) 1211.

• • • • •

Volum

In t
formal
come
teron
sectio
asymm
^{3}He ta
of the
H(α, ^{3}
exists
tering
center
has bee
the ent
polariz
for eith
elastic
Man
the obs
tion in
energy.
interes
larity i
ization
tion of
tion (6-
duced a
howeve
mation
^{3}He(d,p
trance c
the asm
This
ments o

* Work
Comm
** Now a
Califo

C is what we need ... C ... k

$$\Rightarrow \quad \delta(k-k') = \int C_k^* \phi_k^*(r)\, C_k' \, \phi_{k'}(r)\, d^3r$$

⇒ Normalization to unit flux.

For energies $E \ll 700$ keV

$$C_k \sim e^{-\pi\eta}$$

$$\sigma \sim \ldots |C_k|^2 \longrightarrow e^{-2\pi\eta}$$

$$\eta = \frac{\mu e^2}{\hbar^2 k} = \frac{e^2}{\hbar c}\frac{\mu c}{\sqrt{2\mu E}} = \frac{e^2}{\hbar c}\left(\frac{\mu c^2}{2E}\right)^{1/2}$$

$$= \frac{10^4}{137}\left(\frac{10}{E_{eV}}\right)^{1/2} \qquad \mu c^2 \sim 2\,\text{GeV}$$

Coulomb or the Gamow factor

$$E \sim 1\,\text{MeV} \qquad E_{eV} \sim 1\,\text{eV} \quad e^{-2\pi \frac{10}{137}\sqrt{10}} \sim e^{-15} \qquad \boxed{e^{-2\pi \frac{10^4}{137}\sqrt{10}}}$$

No good, too small even to be vaguely interesting:

Objections - my lord

1) In Pd Deuterons are not free.
2) We know that the potential is (must be) screened
3) What about the lattice, what about the lattice.

W. K. B $\qquad l=0 \qquad$ spherical symmetric

$$\varphi'' + \left(k^2 - \frac{2\mu}{\hbar^2}\frac{e^2}{r}\right)\varphi = 0 \qquad \text{free} \sim \frac{\varphi}{r}$$

$y = kr$

$$\frac{d^2\varphi}{dy^2} + \left[1 - \frac{2\eta}{y}\right]\varphi = 0$$

$\Rightarrow$ I ~ Tunneling Probability

$$\sim \left[e^{-2\int_0^{y_0}\left(-1+\frac{2\eta}{y}\right)^{1/2}dy}\right] \equiv e^{-\lambda}$$

where y_0 is the turning point, in this case $y_0 = 2\eta$

$$\lambda = 2\int_0^{2\eta}\left(-1+\frac{2\eta}{y}\right)^{1/2}dy = 4\eta\int_0^1\left(-1+\frac{1}{z}\right)^{1/2}dz$$

$$= 2\eta\pi$$

Screened Coulomb Potential:-

$$\varphi'' + [1 - V(y)]\varphi = 0$$

$$V(r) = \frac{e^2}{r}e^{-r/\lambda_L}$$

λ_L λ_D ~ Debye length

$$\Rightarrow \varphi'' + \left[1 - \frac{2\eta}{y}e^{-y/k\lambda_L}\right]\varphi = 0$$

$$\lambda = 2\int_0^{y_0}\left(\frac{2\eta}{y}e^{-y/k\lambda_L} - 1\right)^{1/2}dy$$

$$\Rightarrow \frac{2\eta}{y_0}e^{-y_0/k\lambda_L} = 1 \qquad \mu = y_0/k\lambda_L$$

$$\Rightarrow \mu e^{\mu} = \frac{e^2/\lambda_L}{(\hbar^2k^2/2\mu)}$$

$$\frac{\hbar^2k^2}{2\mu} \sim E_k \sim \frac{1}{40}\text{ eV at Room temp}$$

$$e^2/\lambda_L \sim 10\text{ eV} \qquad \lambda_L \sim 1\,\mathring{A}$$

$\boxed{\mu \gg 1}$

$$\lambda > 2\int_0^{y_0}\frac{(2\eta)^{1/2}}{y^{1/2}}e^{-y/2k\lambda_L}dy$$

$$= 2(2\eta)^{1/2}\int_0^{\mu/2}e^{-z^2}(2k\lambda_L)^{1/2}dz$$

$$\simeq 2(2\eta)^{1/2}(2k\lambda_L)^{1/2}\sqrt{\pi}/2$$

$$= \left[2\frac{\mu e^2}{\hbar k^2}2k\lambda_L\pi\right]^{1/2} = 2\pi\left(\frac{\mu e^2\lambda_L}{\hbar^2\pi}\right)^{1/2}$$

$$k \longrightarrow \pi/\lambda_L \longrightarrow (\quad)^{1/2}$$

Gamov factor does go down. But how much.

Let $\lambda_L = 1A^0$

$$\lambda = 2\pi \left[\frac{2 \times 2000 \times 10^{-27} \times 10^{-8}}{\pi} \right]^{1/2} \cdot \frac{4.8 \times 10^{-10}}{10^{-27}}$$

$$= 2\pi \left(\frac{4}{\pi}\right)^{1/2} \times 48$$

Clearly lot better but unfortunately not enough, in fact, nowhere near enough.

$$\boxed{\lambda = 2\pi \cdot 250}$$

Large No. of calculations to calculate λ_L, classical, as well as quantum. Degenerate Fermi gas (interacting) calculations etc ⟶

$\lambda_L \sim A^0$ or $\cdot 5\ A^0$ ......

⇒ One falls ~~even~~ 10 orders of magnitude short of explaining even weak expts like Jones & Rafeski, Frascati }

Thus using screened potential for essentially free D - e ~~electron~~ gas (permanently-confined) does not seem to be helpful

Alternative Approach

Hydrogen Deuterium can exist in the molecular or molecule-like states

In fact the exchange interactions due to a very large no. of Pd. electrons (10 d electrons in the outer shell...) can cause an effective attractive potential between Deuterons in some range.

⇒ The Coulomb repulsion is overrated, and we must look at it again:

$$\sigma(E) \sim \frac{S(E)}{E}\, e^{-2\pi\eta} \Rightarrow e^{-2\int_0^r \kappa(r)\,dr}$$

$$V(r) = \cdot 1745 \left[e^{-2.08(r-1.4)} - 2e^{-1.04(r-1.4)} \right]$$

$1.1 < r < 3$ [measured in Bohr radii]

K.W Morse - Potential

$A, \alpha, r_0, \beta \longrightarrow$ Born- Oppen ---

upon the effective mass of the electron

$m^*_{\bullet} \sim 5\ m_e$ → Jones

$m^* = 10\ m_e$ → p. F

⇒ This is just not in the cards, it seems.

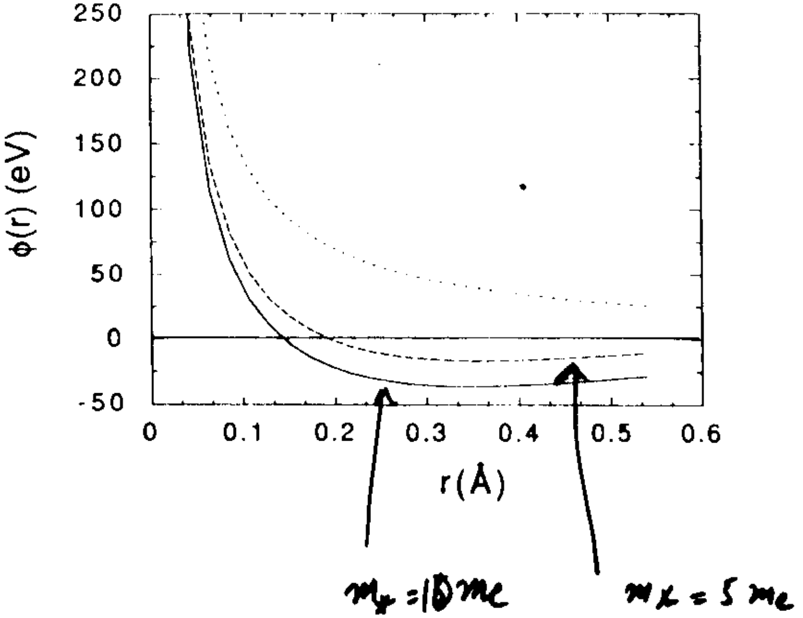


Fig. 1

Dallas Conference

' What are you Dr. Pons? Are you Prometheus, or Pandora or the Piltdown man?

⇒ The protagonists were generally lionized; Pons fielded all questions with confidence, authority, humour ....

⋮

Baltimore APS meeting:

The days of innocence are over, Open Criticism begins:

rime Adversary :- A chemist Nathan Lewis of Cal.

? Not only neutrons, γ-rays, He ---

but also heat measurements

In a set of quite thorough expts, he sees no indication of the claims and offers that Calorimetry by Pons–F. was very poor. Definition of Q is suspect.

MIT group :- Calibrated NaI crystal was one and found the characteristic Spectrum of $n+p \to D+\gamma$.

(i) The line observed by H-P-F was 3 times narrower than it should be

(ii) $n+p \to D+\gamma$ peaks at 2.24 MeV while what H-P-F observes peaks at 2.45 MeV

The peak theo H-P-W observed was probably from Radioactive Radon → Bismuth.

⇒ One could not believe the estimated neutron count.

Helium^4

P-F reported He^4 ⟶ 5-10 times He^4 required to explain heat: He^4 These values are Consistent with the background in Chem. Labs.

⇒ Baltimore meeting ~ Fusion Session drove all passers-by, hangers-on away.

Most experimental claims after the meeting were retracted:

P.F , Texas A&M
⇓
By Consensum

⇒ Much better experiment, much more

carefully done in a controlled manner.

They find excess heat ~ 20%

A whole array of cells:

They find some neutrons, and some heat but there is no correlation whatsoever between the cells that give heat and those that give neutrons

Their heat production is explained by Lewis etc. as coming from Catalytic Recombination

Proper Energy Balance: –

V_{ap} V_i

$V_{ap} - V_i = V_{eff}$

$P = I V_{eff}$ →

→ Part of this V_i is given back by recombination.

A Thorough German-Study has shown in detail that all the relevant ~~energy~~ energy balance problems have a Chemical Solution (No Fusion)

In Expts like Jones, it is becoming clear that the rods show ~~f~~ some fissures some flaking, and also the neutrons probably come out in bursts:

True in Frascati, Trieste . . .

No. of neutrons is small but still uncomfortably large

⇒ Probably localized fusion (hot) is taking place because large E fields can be generated by subjecting metals to immense stresses.

I Believe that foundations of nuclear physics are not yet being fundamentally questioned;

neither is the fact that fusion is yet a few miles away.

Palladium Rod was completely wet

Water bath ⟺ Background (ambient)

Deuterium loaded sheet → Scalded the table plate

Light Water sheet →

Not always reproducible