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About Dynamic Fusion

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Abstract: In nuclear fusion process two or more atomic nuclei join together, or "fuse", to form a single heavier nucleus. During this process, matter is not conserved because some of the mass of the fusing nuclei is converted to energy which is released. The binding energy of the resulting nucleus is greater than the binding energy of each of the nuclei that fused to produce it. This produces an enormous amount of energy. Hot fusion is currently a difficult goal to accomplish due to the high temperatures required, which are difficult to achieve and also to be maintained. For these reason, it is much easier to try to achieve cold fusion, or a combined method. In this paper, the author will briefly present some original relationships for setting up a theoretical model for cold fusion. It will be determined the radius of a moving elementary particle and will be calculated the potential energy of the two adjacent particles. In addition, the necessary speed of the accelerated particles when they will collide to start cold fusion will be determined. The radius of an electron or a nucleus at rest is close to nano sizes. Because of this (static) the fusion working with nanoparticles. It was evaluated that dynamic nanoparticles dimensions are much smaller than when they are at rest.

Keywords: Dynamic cold fusion, moving particle radius, potential energy, kinetic energy, accelerated particles speed, Deuteron.

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Introduction

In general, for determining the size of atomic and subatomic particles their static diameters (ie when the particle is at rest) are used, which is calculated by various approximated methods (Halliday and Robert, 1966). These dimensions are of the order of nano, pico or slightly lower size (Kenneth S. Krane, 1988).

The real phenomena occur when these particles are in dynamically movement and it is therefore necessary to know the real dimensions of the particles in movement.

This paper aims to accomplish this. The parameters required for the fusion of two Deuterium particles will be calculated.

The known nano fusion parameters will be replaced with dynamic fusion parameters.

The first one will determine the necessary speed of the accelerated particles needed to start cold fusion when they collide.

The second one will determine the radius of a moving Deuterium particle.

The third one will calculate the potential energy of the two adjacent Deuterium particles on fusion.

This is the kinetic energy that must reach a Deuterium particle accelerated to produce fusion by collision (Petrescu and Calautit, 2016 a-b; Petrescu and Petrescu, 2014, 2012, 2011; Petrescu et al., 2017 a-f, 2016 a-c).

In nuclear fusion process two or more atomic nuclei join together, or "fuse", to form a single heavier nucleus. During this process, matter is not conserved because some of the mass of the fusing nuclei is converted to energy which is released. The binding energy of the resulting nucleus is greater than the binding energy of each of the nuclei that fused to produce it. This produces an enormous amount of energy.

Creating the required conditions for fusion on Earth is very difficult, to the point that it has not been accomplished at any scale for Protium, the common light isotope of hydrogen that undergoes natural fusion in stars.

Today we know that not only the second isotope of hydrogen (Deuterium) produces fusion energy, but and the third (heavy) isotope of hydrogen (Tritium) can produce energy by nuclear fusion.

The first reaction is possible between two nuclei of Deuterium, from which can be obtained, one Tritium nucleus plus a proton and energy, or an isotope of helium with a neutron and energy (expressions 1-2).

$$ {}_1^2D + {}_1^2D \rightarrow {}_1^3T + 1.01MeV + {}_1^1H + 3.02MeV = {}_1^3T + {}_1^1H + 4.03MeV \quad (1) $$

ISSN: 1415-7314
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$$ {}_{1}^{2}D+{}_{1}^{2}D\rightarrow{}_{2}^{3}He+0.82MeV+{}^{1}n+2.45MeV={}_{2}^{3}He+{}^{1}n+3.27MeV \quad (2) $$

Observations: a Deuterium nucleus has a proton and a neutron; a Tritium nucleus has a proton and two neutrons.

Fusion can occur between a nucleus of Deuterium and one of Tritium (expression 3).

$$ {}_{1}^{2}D+{}_{1}^{3}T\rightarrow{}_{2}^{4}He+3.5MeV+{}^{1}n+14.1MeV={}_{2}^{4}He+{}^{1}n+17.6MeV \quad (3) $$

Another fusion reaction can be produced between a nucleus of Deuterium and an isotope of helium (expression 4).

$$ {}_{1}^{2}D+{}_{2}^{3}He\rightarrow{}_{2}^{4}He+3.6MeV+{}_{1}^{1}H+14.7MeV={}_{2}^{4}He+{}_{1}^{1}H+18.3MeV \quad (4) $$

For these reactions to occur, should that the Deuterium nuclei have enough kinetic energy to overcome the electrostatic forces of rejection due to the positive tasks of protons in the nuclei.
For Deuterium for average kinetic energy required tens of keV.
For 1 keV are needed about 10 million degrees temperature.
The huge temperature is done with high power lasers acting hot plasma.
Electromagnetic fields are arranged so that it can maintain hot plasma.
The best results were obtained with the Tokamak-type installations.
Deuterium fuel is delivered in heavy water, D_2O.
Tritium is obtained in the laboratory by the following reaction (expression 5).

$$ {}_{3}^{6}Li+{}^{1}n\rightarrow{}_{1}^{3}T+{}_{2}^{4}He+4.784MeV \quad (5) $$

Lithium, the third element in Mendeleev's table, is found in nature in sufficient quantities.
The accelerated neutrons which produce the last presented reaction with lithium, appear from the second and the third presented reaction.
Raw materials for fusion are Deuterium and lithium.
All fusion reactions shown produce finally energy and He. He is an inert (gas) element. Because of this, fusion reaction is clean, and far superior to nuclear fission.
In cold fusion, it must accelerate the Deuterium nucleus (positive ion of Deuterium), in linear or circular accelerators. Final energy of accelerated Deuterium nuclei should be well calibrated for a positive final yield of fusion reactions (more mergers, than fission).

Materials and Methods

ISSN: 1415-7314
ISSN online: 2317-6717

Any elementary moving particle possesses the kinetic energy given by the relationship 6 (composed by two components: the kinetic energy of motion translational and rotational kinetic energy of motion).

$$E_c = \frac{1}{2} m \cdot v^2 + \frac{1}{2} J \cdot \omega^2 \tag{6}$$

The mass of particle is determined with the Lorentz relationship 7.

$$m = \frac{m_0 \cdot c}{\sqrt{c^2 - v^2}} \tag{7}$$

Mechanical moment of inertia (mass) of particle (around its axis of rotation) is determined by the relationship 8.

$$J = \frac{2}{5} m \cdot R^2 \tag{8}$$

This is the mass moment of inertia of a sphere (see the Fig. 1).

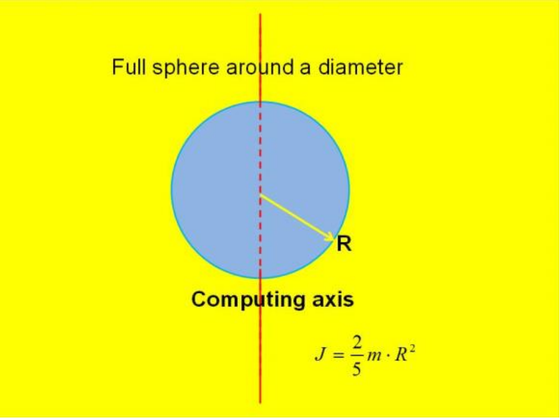

Fig. 1 - Mass moment of inertia to a full sphere, determined around a diameter

Using the forms 7 and 8 the relationship 6 takes the forms 9.

$$\begin{cases} E_c = \frac{1}{2} m \cdot v^2 + \frac{1}{2} \cdot \frac{2}{5} \cdot m \cdot R^2 \cdot \omega^2 \\ E_c = \frac{1}{2} \frac{m_0 \cdot c \cdot v^2}{\sqrt{c^2 - v^2}} + \frac{1}{2} \cdot \frac{2}{5} \cdot \frac{m_0 \cdot c \cdot R^2}{\sqrt{c^2 - v^2}} \cdot \omega^2 \end{cases} \tag{9}$$

Pulse of the particle is written using the relation 10.

$$p = m \cdot v = \frac{m_0 \cdot c \cdot v}{\sqrt{c^2 - v^2}} \tag{10}$$

The wavelength associated with the particle can be determined with the relationship 11 (according to Louis de Broglie the pulse is conserved).

$$\lambda = \frac{h}{p} = \frac{h \cdot \sqrt{c^2 - v^2}}{m_0 \cdot c \cdot v} \tag{11}$$

Wave frequency associated with the particle is determining by relationship 12.

$$\gamma = \frac{c}{\lambda} = \frac{c \cdot m_0 \cdot c \cdot v}{h \cdot \sqrt{c^2 - v^2}} = \frac{m_0 \cdot c^2 \cdot v}{h \cdot \sqrt{c^2 - v^2}} \tag{12}$$

The angular velocity of the particle and its square can be calculated with the relationships 13.

$$\begin{cases} \omega = 2\pi\gamma = \dfrac{2\pi \cdot m_0 \cdot c^2 \cdot v}{h \cdot \sqrt{c^2 - v^2}} \\ \omega^2 = \dfrac{4\pi^2 \cdot m_0^2 \cdot c^4 \cdot v^2}{h^2 \cdot (c^2 - v^2)} \end{cases} \tag{13}$$

Using 13 the relationship 9 takes the forms 14.

$$\begin{cases} E_c = \dfrac{1}{2} \dfrac{m_0 \cdot c \cdot v^2}{\sqrt{c^2 - v^2}} + \dfrac{1}{2} \cdot \dfrac{2}{5} \cdot \dfrac{m_0 \cdot c \cdot R^2}{\sqrt{c^2 - v^2}} \cdot \dfrac{4\pi^2 \cdot m_0^2 \cdot c^4 \cdot v^2}{h^2 \cdot (c^2 - v^2)} \\ E_c = \dfrac{1}{2} \dfrac{m_0 \cdot c \cdot v^2}{\sqrt{c^2 - v^2}} \cdot \left[1 + \dfrac{8}{5} R^2 \cdot \pi^2 \dfrac{m_0^2 \cdot c^4}{h^2 \cdot (c^2 - v^2)} \right] \end{cases} \tag{14}$$

The kinetic energy of the moving particle can be determined and by the relationship 15. From the total energy of the particle in movement, subtract the total energy of the particle at rest (potential energy), (Petrescu and Calautit, 2016 a-b; Petrescu and Petrescu, 2014, 2012, 2011; Petrescu et al., 2017 a-f, 2016 a-c).

$$E_c = E - E_0 = m \cdot c^2 - m_0 \cdot c^2 = m_0 \cdot c^2 \cdot \frac{c - \sqrt{c^2 - v^2}}{\sqrt{c^2 - v^2}} \tag{15}$$

Identifying the relationships 14 and 15 are obtained the expressions 16 which can determine the radius of an elementary moving particle.

$$\begin{cases} \frac{1}{2}\frac{m_0 \cdot c \cdot v^2}{\sqrt{c^2 - v^2}} \cdot \left[1 + \frac{8}{5}R^2 \cdot \pi^2 \frac{m_0^2 \cdot c^4}{h^2 \cdot (c^2 - v^2)}\right] = m_0 \cdot c^2 \cdot \frac{c - \sqrt{c^2 - v^2}}{\sqrt{c^2 - v^2}} \\ R = \sqrt{\frac{10}{8}} \cdot \frac{h}{\pi \cdot m_0 \cdot c^2} \cdot \frac{\sqrt{c^2 - v^2} \cdot \sqrt{c^2 - \frac{v^2}{2} - c \cdot \sqrt{c^2 - v^2}}}{v} \\ R = \sqrt{\frac{10}{8}} \cdot \frac{h \cdot \sqrt{c^2 - v^2} \cdot \sqrt{c^2 - \frac{v^2}{2} - c \cdot \sqrt{c^2 - v^2}}}{\pi \cdot m_0 \cdot c^2 \cdot v} \end{cases} \quad (16)$$

It is known and the expression of potential energy between two adjacent particles (electrostatic potential energy), which should be the energy with that a particle needs to be accelerated before to collide (relationships 17, Fig. 2), (Petrescu F.I.T., 2015, 2014, 2012, 2011). This electrostatic potential energy must to be the same with the (final) kinetic energy of motion translational of accelerated particle E_p=1/2mv^2.

$$\begin{cases} E_p = \frac{1}{4\pi \cdot \varepsilon_0} \cdot \frac{q_1 \cdot q_2}{d_{12}} = \frac{q_1 \cdot q_2}{8\pi \cdot \varepsilon_0 \cdot R} \\ E_c = \frac{1}{2} m \cdot v^2 \\ E_p \le E_c \end{cases} \quad (17)$$

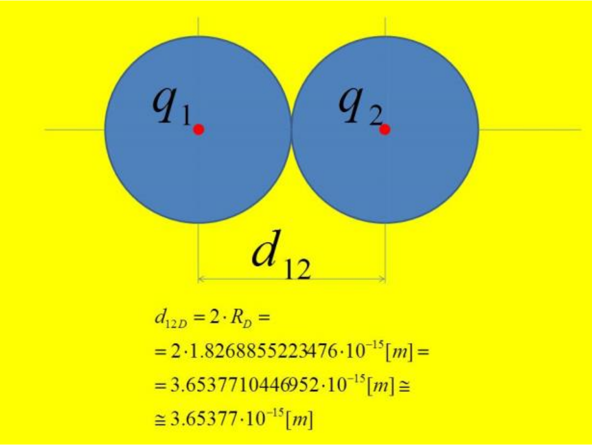

Fig. 2. Two adjacent particles of Deuterium

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The radius of Deuterium at rest (without motion), was determined in Fig. 2 according to the following relationship 18 (Petrescu and Calautit, 2016 a-b; Petrescu and Petrescu, 2014, 2012, 2011; Petrescu et al., 2017 a-f, 2016 a-c).

$$\begin{cases} R_D = r_0 \cdot A^{1/3} \\ r_0 = 1{,}45E - 15[m] \text{the average radius} \\ \text{of a nucleon fixed} \\ \text{A} = \text{the atomic mass} \end{cases} \quad (18)$$

With relationship 16 one can determine with very high accuracy the radius of a Deuteron or any other elementary moving particle, as a function of its velocity, v. The kinetic energy produced by the rotation of the particle is expressed by the relationship 19.

$$\begin{cases} E_{c\omega} = \frac{1}{2} \cdot \frac{2}{5} \cdot m \cdot R^2 \cdot \omega^2 = \\ = \frac{2}{10} \cdot m \cdot R^2 \cdot \frac{4\pi^2 \cdot m^2 \cdot c^2 \cdot v^2}{h^2} = \\ = \frac{8}{10} \frac{\pi^2 \cdot m^3 \cdot c^2 \cdot v^2 \cdot R^2}{h^2} \end{cases} \quad (19)$$

In order to produce the fusion of two particles they must be brought close together with potential energy expressed by the relationship 17, where the electrostatic potential energy of particle was replaced by $E_p=1/2mv^2$. For this reason the length of a particle radius (in movement) may be determined from relationship 12, taking the expression 20.

$$R = \frac{q_1 \cdot q_2}{4\pi \cdot \varepsilon_0 \cdot m \cdot v^2} \quad (20)$$

Using the relationship 20, expression 19 takes the form 21.

$$E_{c\omega} = \frac{(q_1 \cdot q_2)^2 \cdot c^2 \cdot m}{20h^2 \cdot \varepsilon_0^2 \cdot v^2} \quad (21)$$

The kinetic energy produced by the rotation of the particle (expressed by the relationship 21) may be written and by expression 22. From the total energy of the moving particle, subtract the kinetic energy produced by the translational motion of the particle and the total energy of the particle at rest (potential energy), (Petrescu F.I.T., 2015, 2014, 2012, 2011).

$$E_{c\omega} = m \cdot c^2 - \frac{1}{2} m \cdot v^2 - m_0 \cdot c^2 \quad (22)$$

Equaling expressions 21 and 22 obtains the equation 23, in v^2.

$$m \cdot c^2 - \frac{1}{2} m \cdot v^2 - m_0 \cdot c^2 = \frac{(q_1 \cdot q_2)^2 \cdot c^2 \cdot m}{20h^2 \cdot \varepsilon_0^2 \cdot v^2} \tag{23}$$

The equation 23 takes the forms 24-31.

$$mc^2 - m_0 c^2 = \frac{(q_1 q_2)^2 c^2 m + 10 m v^4 h^2 \varepsilon_0^2}{20h^2 \cdot \varepsilon_0^2 \cdot v^2} \tag{24}$$

$$\frac{m_0 c^2 \left(c - \sqrt{c^2 - v^2}\right)}{\sqrt{c^2 - v^2}} = \frac{c m_0 [(q_1 q_2)^2 c^2 + 10 h^2 \varepsilon_0^2 v^4]}{20h^2 \cdot \varepsilon_0^2 \cdot v^2 \sqrt{c^2 - v^2}} \tag{25}$$

$$20h^2 \varepsilon_0^2 v^2 \left(c^2 - c\sqrt{c^2 - v^2}\right) = (q_1 q_2)^2 c^2 + 10 h^2 \varepsilon_0^2 v^4 \tag{26}$$

$$\begin{cases} 20h^2 \varepsilon_0^2 v^2 c^2 - 20h^2 \varepsilon_0^2 v^2 c \sqrt{c^2 - v^2} = \\ = (q_1 q_2)^2 c^2 + 10 h^2 \varepsilon_0^2 v^4 \end{cases} \tag{27}$$

$$\begin{cases} 20h^2 \varepsilon_0^2 v^2 c^2 - (q_1 q_2)^2 c^2 - 10 h^2 \varepsilon_0^2 v^4 = \\ = 20h^2 \varepsilon_0^2 v^2 c \sqrt{c^2 - v^2} \end{cases} \tag{28}$$

$$\begin{cases} (20h^2 \varepsilon_0^2 v^2 c^2 - (q_1 q_2)^2 c^2 - 10 h^2 \varepsilon_0^2 v^4)^2 = \\ = 400 h^4 \varepsilon_0^4 v^4 c^2 (c^2 - v^2) \end{cases} \tag{29}$$

$$\begin{cases} 100 h^4 \varepsilon_0^4 x^4 + 200 h^4 \varepsilon_0^4 c^2 x^3 + 20 h^2 \varepsilon_0^2 c^2 (q_1 q_2)^2 x^2 - 40 h^2 \varepsilon_0^2 c^4 (q_1 q_2)^2 x + (q_1 q_2)^4 c^4 = 0 \\ \\ with \quad x = v^2 \end{cases} \tag{30}$$

$$\begin{cases} x^4 + ax^3 + bx^2 - cx + d = 0 \\ \\ a = 2c^2 \\ b = \dfrac{c^2 (q_1 q_2)^2}{5h^2 \varepsilon_0^2} \\ c = \dfrac{2c^4 (q_1 q_2)^2}{5h^2 \varepsilon_0^2} \\ d = \dfrac{c^4 (q_1 q_2)^4}{100 h^4 \varepsilon_0^4} \end{cases} \quad (31)$$

Solving the equation 31 in v^2 one obtains the value v for velocity of the accelerated particle required for fusion (expression 32).

$$\begin{cases} v^2 = 4.784\mathrm{E} + 11[\mathrm{m}^2/\mathrm{s}^2] \\ v = 691664.8602[\mathrm{m/s}] \\ \beta = \mathrm{v/c} = 0.002307088 \end{cases} \quad (32)$$

Results and Discussion

First one should determine the necessary speed of the accelerated particles needed to start cold fusion when they will collide. It may use the equation 31 (Petrescu F.I.T., 2015, 2014, 2012, 2011).

This speed has the value: v= 691664.8602 [m/s]

Second one could determine the radius of a moving deuterium particle using the relationship 33 (extract from 16), (Petrescu and Calautit, 2016 a-b; Petrescu and Petrescu, 2014, 2012, 2011; Petrescu et al., 2017 a-f, 2016 a-c).

$$R = \sqrt{\frac{10}{8}} \cdot \frac{h \cdot \sqrt{c^2 - v^2} \cdot \sqrt{c^2 - \frac{v^2}{2} - c \cdot \sqrt{c^2 - v^2}}}{\pi \cdot m_0 \cdot c^2 \cdot v} \quad (33)$$

Third one may calculate the potential energy of the two adjacent Deuterium particles on fusion. This is the minimum translational kinetic energy that must reach a Deuterium particle accelerated to produce fusion by collision (using the form 34 of relationship 17).

$$E_p = \frac{q_1 \cdot q_2}{8\pi \cdot \varepsilon_0 \cdot R} \quad (34)$$

With m_0 Deuteron=3.34524E-27[kg]

v= 691664.8602 [m/s]

The radius of Deuteron at this velocity (calculated with relationship 33) takes the below value:

RD=1.91788E-19 [m] (dynamic at v=0.002307088c)

Static RD=1.827E-15 [m].

Potential energy has the below value (Petrescu and Calautit, 2016 a-b; Petrescu and Petrescu, 2014, 2012, 2011; Petrescu et al., 2017 a-f, 2016 a-c):

U=Ep=6.01333E-10 [J]= 3753521838 [eV]= 3753521.838 [KeV]= 3753.521838 [MeV]= =**3.753521838 [GeV]**

It needs to accelerate a Deuteron with minimum 3.76 GeV to prepare it, and then one collide these accelerated Deuterium ions to start the fusion process. Today, cold fusion requires a storage and maintenance stage of the merger process somewhat similar to hot fusion, while hot fusion can't be achieved only at high temperatures, but also other complementary measures. For this reason we must speak about a combined method for fusion (De Ninno et al., 2002). Anyway, it would not conclude that "cold fusion" it is "much easier than hot fusion".

Expression 33 has the advantage to give the dynamic radius of one particle at any velocity except the two limits when v=c or v=0.

If v=c the particle become a photon and one can use other equations.

Conclusions

Dynamic, the matter focuses! Hot fusion is currently a difficult goal to accomplish (Aversa et al., 2017 a-c, 2016 a-d). Hot fusion temperature required is huge and difficult to achieve and much less to be supported and maintained. For these reasons it is much easier to try to achieve cold fusion, or a combined method. The presented paper briefly shows some original relationships which can help to set up a theoretical model for cold fusion (combined fusion). One should determine the necessary speed of the accelerated particles so that when they will collide to start cold fusion. Then, it will determine the radius of a moving particle and calculate the potential energy of the two adjacent particles. A nucleus at rest is close to nano size. Because of this (static) the fusion working with nanoparticles. But it was shown that dynamic particles dimensions are much smaller than when they are at rest. We may speak about a dynamic fusion (and not a nano one). Two new relationships 32, 33 were introduced.

Assumptions Used

1-The assumption that frequency of the particle associate wave is the same with rotation frequency of the particle (the rotation of the particle produces the associate wave) was used.

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2-The assumption that expression of potential energy between two adjacent particles (electrostatic potential energy), should be the same with minimum translational kinetic energy with that a particle needs to be accelerated before its collision.

Importance

With the new expression (33) introduced one can determine the radius of any elementary particle in movement.

In the (below) table 1 it can see the radius of an electron in movement (determined with expression 33) in function of β (where β is the ratio between v and c; expression 35:

$$\beta = \frac{v}{c} \tag{35}$$

Table 1 The electron radius in function of β

β	0.000009	0.00002	0.0001
R[m	4.93E-16	4.07E-16	8.15E-17
β	0.001	0.01	0.1
R[m	3.05E-16	3.05E-15	3.04E-14
β	0.2	0.3	0.4
R[m	6.04E-14	8.94E-14	1.16E-13
β	0.5	0.6	0.7
R[m	1.41E-13	1.62E-13	1.78E-13
β	0.8	0.9	0.99
R[m	1.83E-13	1.66E-13	7.47E-14
β	0.999	0.9999	0.99999
R[m	2.61E-14	8.51E-15	2.71E-15
β	0.999999	0.9999999	0.9999999
R[m	8.62E-16	2.72E-16	8.63E-17

Table 2 The proton radius in function of β

ISSN: 1415-7314
ISSN online: 2317-6717

β	0.000009	0.00002	0.0001
R[m	2.68E-19	2.21E-19	4.43E-20
β	0.001	0.01	0.1
R[m	1.66E-19	1.66E-18	1.65E-17
β	0.2	0.3	0.4
R[m	3.29E-17	4.87E-17	6.36E-17
β	0.5	0.6	0.7
R[m	7.71E-17	8.86E-17	9.69E-17
β	0.8	0.9	0.99
R[m	9.97E-17	9.08E-17	4.06E-17
β	0.999	0.9999	0.99999
R[m	1.42E-17	4.63E-18	1.48E-18
β	0.999999	0.9999999	0.9999999
R[m	4.69E-19	1.48E-19	4.70E-20

Dynamic, at low or high velocities the matter focuses. One can determine the value of average radius of an electron 1.09756E-13 [m], and its maximum value 1.83152E-13 [m] obtained for β=0.8. In the same mode one determines the radius of a proton in movement (table 2).

One can determine the value of average radius of a proton (or neutron) 5.9779E-17 [m], and its maximum value 9.97547E-17 [m] ≅ 1E-16 [m] obtained for β=0.8 (Petrescu F.I.T., 2015, 2014, 2012, 2011).

Observations

Even the electron mass is smaller than the proton or neutron (nucleon) mass, the electron size is greater than the nucleon size (Petrescu et al., 2017 a-f; Petrescu F.I.T., 2015, 2014, 2012, 2011).

When the number of nucleons increases (when the atomic mass A, the mass of nucleus, increases) the nucleus size decreases. In a deuterium nucleus we have two nucleons (a proton and a neutron). These are the results of the new expression 33 indicating a matter compression inversely proportional to the mass (see the below values).

m_0 electron=9.11E-31[kg]=>Re=1.09756E-13 [m];

m_0 proton=1.67262E-27[kg]=>Rp=5.9779E-17 [m];

m_0 Deuteron=3.3452E-27[kg]=>R_D=2.9889E-17[m].

For fusion, cold or hot, one must use positive ions of Deuterium called Deuterons, to have the possibility to accelerate them.

Utilization and Comments

The average value of a Deuteron radius is 2.98895E-17 [m]. With this Deuteron radius value, using the expression (29) one may determine the translational kinetic energy with that needs to accelerate this particle before collide it:

U=Ep=3.85849E-12 [J]=24084723.86 [eV]=24084.72386 [keV]=24.08472386 [MeV]

In this way we can eliminate the second (dynamic) assumption.

Or U=3.76 [GeV] with the new dynamic theory;

Or U=24[MeV] using an average value for the Deuteron radius.

However, the final word will be said only by more practical experiments. The authors think that real process is one dynamic and recommend a minimum U=3.76 GeV).

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Nomenclature

ε_0 => the permissive constant (the permittivity):
ε_0 =8.85418 E-12 [C^2/Nm^2]
h=> the Planck constant:
h=6.626 E-34 [Js]
q=> electrical elementary load:
q_e=-1.6021 E-19[C]
q_p=1.6021 E-19[C]
c= the light speed in vacuum:
c=2.997925 [m/s]
m_0[kg] => the rest mass of one particle
$m_{0electron}$ = 9.11E-31 [kg]
$m_{0proton}$ = 1,6726219E-27 [kg]