American Journal of Applied Sciences

Original Research Paper

Presenting a New Equation that Accurately Determines the Size of a Moving Elementary Particle

Florian Ion Tiberiu Petrescu

Theory of Mechanisms and Robots, Bucharest Polytechnic University, Romania

Article history
Received: 16-09-2022
Revised: 05-11-2022
Accepted: 10-11-2022

Email: tiberiuflorianion@gmail.com

Abstract: The paper briefly presents a new Eq. (9). The role of Eq. (9) is to accurately determine the size of a moving elementary particle, depending on its velocity (or particle energy). Although Eq. (9) has a general character, it can be applied to any elementary particle in motion to determine the size of that particle, in the study, it was applied only to the particles of hydrogen nuclei of its first three isotopes. The purpose of the application is to determine exactly the size of hydrogen isotopes according to their energy, to use in industrial systems for obtaining nuclear energy, fusion, fission, and, in the future, even the annihilation of matter-antimatter. In this way, it will be possible to achieve industrial-scale fusion with convenient efficiency in the coming years and a little later it will be possible to develop systems for obtaining energy from annihilations.

Keywords: Nuclear Energy, Condensed Matter, Quantum Physics, Hydrogen Isotopes Dimension, Photon Quantification, Photon Kinetic Moment

Introduction

Practically, there is still no well-developed equation to realize what the new Eq. (9) (introduced during this work) can do, to determine precisely the size of an elementary particle in motion, depending on its energy (or the speed at which it moves). About three years ago, the author successfully introduced such an equation (1) (Petrescu, 2019; Petrescu and Petrescu, 2019), but the theory at the time had some limitations in the area of low speeds ($\beta<0.3$) in the sense that in that area the Eq. (1) present an unexpected condensation of matter. It is known that matter condenses with the increase of energy (or the rate of displacement of an elementary particle), so in the area of low velocities (energies) a condensation of matter as indicated by the theory at that time (Eq. 1) was not expected, so that although the only precision equation for the dynamic determination of the dimensions of the elementary particles introduced then (Eq. 1), was no longer accurate in the area of low velocities. The author has been looking all this time for a theoretical possibility to remedy this and here it is now fulfilled and is presented in the new work (Eq. 9). The first theory of the size of a hydrogen atom was developed by Niels Bohr (1913a), with his atomic model (Niels Bohr, 1913b). The model deduced the radius with which the electron moves around the hydrogen atom, so basically, it deduced the radius of the hydrogen atom, static, not for one in motion (Niels Bohr, 1913b). Later, Bohr's model of the hydrogen atom was generalized to any kind of atom, but only to the static (non-dynamic, not moving atoms). Now we had a general equation for determining the size of an atom, but not when it is moving at a certain velocity v, nor is there yet an equation for the size of moving elementary particles.

The author's earlier efforts to deduce an equation for the size of any moving elementary particle (Eq. 1) (Petrescu, 2019; Petrescu and Petrescu, 2019) were based on de Broglie's hypothesis (de Broglie, 1923) that the momentum is conserved when moving from a moving elementary particle to its associated wave. De Broglie's hypothesis of matter waves postulates that any particle of matter that has linear momentum is also a wave. The wavelength of a matter wave associated with a particle is inversely proportional to the magnitude of the particle's linear momentum. The speed of the matter wave is the speed of the particle (de Broglie, 1923). The success of my first Eq. (1) three years ago, meant to dynamically dimension any elementary particle, was based on the interweaving of physical equations with that of de Broglie, $p = h/\lambda$, or $m\cdot v = h/\lambda$, where $p = m\cdot v$ is the impulse of the elementary particle, m is its mass and v is its velocity, $p= h/\lambda$ is the associate photon impulse, λ is the wavelength of the photon and h is the Planck constant. Unwittingly, de Broglie introduced by this equation the quantification of the motion of an elementary particle by Planck's constant h, which he did without realizing Niels Bohr with his atomic model of the hydrogen atom (it was practically the isotope number 1 of hydrogen, the protium). The h/λ portions could be multiplied by the quantum number n without problems, similar to Bohr's case because it could be a portion of energy and momentum (or more) on a single photon or even the energy and momentum of several photons. The fact itself is not very relevant in the final equations because in the end the situation with n = 1 is used in most cases. Practically both scientists, Bohr and de Broglie introduced quantification by introducing Planck's constant, h. Modern quantification consists in introducing the number h into the equation and it is normal to be so because Planck was the first scientist to discover the quantum aspect of light in photon production through his equation and then Einstein was the second scientist who introduced the quantum aspect of the photon energy with its equation $E = h\gamma$ (Einstein, 1905). This is how Bohr and de Broglie introduced the quantum aspect of the motion of an atomic electron and respectively of a moving elementary particle. The condition for quantifying the atom of Bohr, more precisely the rotational motion of the electron around the atom, is usually expressed concerning the kinetic moment (impulse to rotate) of the electron in a circular motion in an orbit inside the atom $L = n \cdot \hbar = n \cdot h/(2\pi)$; where $\hbar = h/(2\pi)$ represents the reduced Planck's constant; n is an integer (1, 2, 3, ...), called the principal quantum number. It is generally considered for n the first value, 1 when $L = \hbar = h/(2\pi)$. Here is the moment of one clarification, namely the fact that in the paper was used this equation of quantification with n = 1 of Bohr, noted in the paper with (3), not for the kinetic moment of the electron rotating around the nucleus of the atom, but for the kinetic moment of a photon (the impulse to the rotation of a photon, around its axis of rotation), equation deduced and explained in the relations (10). Given that the impulse is conserved between a moving elementary particle and the associated wave (associated photon), according to de Broglie, we decided to consider both conservations, both linear and rotational impulse (kinetic moment), and in this way, has been obtained the new equation of motion (9), which dimensions very precisely the elementary particle in motion. In the present paper, the new Eq. (9) was applied for the effective sizing of the first three isotopes of hydrogen, because they all have special importance in obtaining the clean energy of the future, on an industrial scale and with a satisfactory yield.

Next, before moving on to the presentation of the effective equations, there will be a brief presentation of the importance of nuclear energy obtained from hydrogen, along with the energy use of hydrogen today in its various variants.

Because hydrogen is the chemical element located in the periodic table of elements in the first place, with the symbol H and atomic number 1, it is also the most widespread element in nature. Hydrogen is found in nature in the form of highly flammable, odorless, tasteless, and colorless gas, most often in the form of a diatomic molecule, H_2. Having an atomic mass of 1.00794 u.a.m. (units of atomic mass), hydrogen is practically the lightest chemical element. Etymologically, its name is a combination of two Greek words, which sounds like "the one who produces water". It should be emphasized that all cosmic energy is based on hydrogen, but even here on our planet, nothing moves without water and air, oxygen being the key element in both air and water. If in the Earth's atmosphere oxygen coexists with nitrogen, water is formed from oxygen and hydrogen. Practically immediately after oxygen, hydrogen ranks second in the planet's natural energy systems. Moreover, even in the living world, hydrogen ranks second among the four energy elements: Oxygen, hydrogen, nitrogen, and phosphorus. Today we use hydrogen to obtain clean energy from hydrogen, which burns without pollutants and the only product of its combustion is water, thus restoring the natural circuit. When burning simple hydrogen, the toxic carbon compounds obtained by burning hydrocarbons (formed by molecular chains of hydrogen and carbon) are missing. Some secondary compounds can indeed form with nitrogen from the air, but they are generally less polluting than carbon dioxide (or monoxide). The problem of storing liquid hydrogen under pressure has long been solved, but the most elegant way to store hydrogen is water, with the possibility of dissociating water into the desired hydrogen and oxygen.

Because hydrogen burns much faster than hydrocarbons (about 8 times faster than gas and 9 times faster than gasoline) and has a higher calorific value, it is sometimes combined with other elements to be used as a less hazardous fuel, such as ammonia (NH_3) or ammonium (NH_4+). Some jet engines test for ammonia as carbon-free aviation fuel (Szondy, 2020; Petrescu, 2020). Reaction Engines and the UK Council for Science and Technology Facilities (STFC) have jointly launched a major study on fuel diversification and have completed the concept of how practical it is to introduce and use ammonia as a fuel for jet aviation engines, with advanced heat exchanger and STFC technologies, where catalysts have been used to create a new, reliable, low-emission propulsion system for the immediate future so that it can propel aircraft far beyond the speed of sound and carry passengers and goods from all over the globe extremely fast and safe (Verstraete, 2013; Balat, 2008; Sürer and Arat, 2018). The aim is to eliminate fossil fuels from aviation as they produce significant carbon dioxide emissions, which the airline industry and many governments have made a serious commitment, to drastically reduce by 2050.

The future will be much safer only when nuclear fusion energy can be brought under control on an industrial scale. Here the essential role is played by all the hydrogen with its first three isotopes, protium, deuterium, and tritium (Kramer, 2011; Krane, 1991; Moses *et al*., 2009; Reid, 1968; Shultis and Faw, 2016; Durand *et al*., 2000; Heyde, 2004; Ho-Kim and Pham, 2013; Hughes, 1985; Cole, 2000; Meitner and Frisch, 1939; Langmuir, 1919; Lewis, 1916; Mazo, 2002). Efforts to improve nuclear fission reactions are also welcome, especially as these reactions can be improved and carried out on an industrial scale in a controlled manner to produce clean, sustainable, friendly energy. The author of this article has tried over time to improve the possibility of carrying out controlled nuclear reactions on an industrial scale. An important direction of he and many others authors was the precise determination of the structure of matter. However, the studies have been channeled in other directions but also based on the way the matter is structured (Petrescu, 2019; Petrescu and Petrescu, 2019).

Much of the author's research has focused on an original relation (1) by which the dimensions of moving elementary particles can be determined (R = radius of the particle, in meters), depending on their mass and speed of offset, where h is Planck's constant (h = 6.626 E-34 [Js]), c is the speed of light in a vacuum (c = 2.997925 E08 [m/s]), m_0 is the mass of the particle in question (in [kg]) andβ is the ratio of the velocity v of the particle and the speed c of the light in a vacuum (Petrescu, 2019; Petrescu and Petrescu, 2019), $\beta = v/c$ (Halliday and Robert, 1966):

$$R[m]=\sqrt{\frac{5}{4}\cdot\frac{h}{\pi\cdot c\cdot m_0}\cdot\frac{\sqrt{1-\beta^2}}{\beta}\sqrt{1-\frac{1}{2}\beta^2-\sqrt{1-\beta^2}}} \tag{1}$$

For β values in the range 0.4-1, the relation (1) generates correct values for the radius of a moving particle. The problem of this relation is manifested in the range of low values for the velocity v of the particle (for the β range 0-0.4), where the original relation (1) generates very low R values concerning the low velocity of the moving particle. Seeking to remedy this limitation of the relation (1) the author managed to find a new dynamic relation of any elementary particle in motion and the presentation of this new original relation together with its deduction represents the main objective of the present article.

Materials and Methods

One will start from the hypothesis of conserving the circular impulse (at rotation) of the elementary particle of mass m_p (in kg) in linear motion with velocity v_p (in m/s) and which executes at the same time a spin motion, of rotation around its axis with a rotation speed ω_p (in s^{-1}). The rotational impulse L_p (in kg.m^2.s^{-1}, or J.s) (2) of the particle p is the product of the particle rotational mass J_p (in kg.m^2) and the angular velocity ω_p (in s^{-1}) of the particle. The article was considered to be spherical in shape:

$$L_p[kg\cdot m^2\cdot s^{-1}]=J_p\cdot\omega_p=\frac{2}{5}m_p\cdot R_p^2\cdot\omega_p \tag{2}$$

The circular impulse (or the kinetic moment) (3) of the wave associated with the particle (of the associated photon, only one photon) has a simpler shape, it is considered constant because it belongs to the photon (noted with a ph) associated with the particle p, where h is the Planck constant (in J.s):

$$L_{ph}[J\cdot s]=\frac{h}{2\pi} \tag{3}$$

The wave associated with the particle p is produced by its spin and the circular impulse of the particle p is therefore equal to that of the photon(s) (noted with a ph) belonging to the associated wave, ie $L_p = n\cdot L_{ph}$ (4). This is the new hypothesis used in the paper:

$$\begin{cases} L_p=n\cdot L_{ph}\Rightarrow\frac{2}{5}m_p\cdot R_p^2\cdot\omega_p=\frac{n\cdot h}{2\pi}\Rightarrow \\ \omega_p=\frac{5n\cdot h}{4\pi\cdot m_p\cdot R_p^2}\end{cases} \tag{4}$$

But the linear impulse is also preserved, according to de Broglie's hypothesis (5):

$$\begin{cases} p_p=n\cdot p_{ph}\Rightarrow m_p\cdot v_p=\frac{n\cdot h\cdot\gamma_{ph}}{c}\Rightarrow \\ \frac{m_p\cdot c\cdot v_p}{n\cdot h}=\frac{\omega_{ph}}{2\pi}\Rightarrow \\ \omega_{ph}=\frac{2\pi\cdot m_p\cdot c\cdot v_p}{n\cdot h}\end{cases} \tag{5}$$

The frequency of the associated (generated) wave is either equal to that of the rotation of the generating particle p (6):

$$\begin{cases} \omega_p=\omega_{ph}\Rightarrow\frac{5n\cdot h}{4\pi\cdot m_p\cdot R_p^2}=\frac{2\pi\cdot m_p\cdot c\cdot v_p}{n\cdot h}\Rightarrow \\ R_p^2=\frac{5n^2\cdot h^2}{8\cdot\pi^2\cdot m_p^2\cdot c\cdot v_p}=\frac{5n^2\cdot h^2\cdot(1-\beta^2)}{8\cdot\pi^2\cdot m_0^2\cdot c^2\cdot\beta}\end{cases} \tag{6}$$

The most well-known form of Lorentz relativity (7) was also used to deduce the final relation (6):

$$m_p=\frac{m_0}{\sqrt{1-\beta^2}}\Rightarrow m_p^2=\frac{m_0^2}{(1-\beta^2)} \tag{7}$$

Using the final relation (6) is obtained by extracting the square root, the form of the new original (final) expression of the radius R_p (8), in the function of m_0 and β:

$$R_p = \sqrt{\frac{5}{8}}\frac{n \cdot h}{\pi \cdot c \cdot m_0} \cdot \sqrt{\frac{1-\beta^2}{\beta}} \tag{8}$$

The fundamental frequency is obtained for the first value of the principal quantum number n = 1 (9):

$$R_p = \sqrt{\frac{5}{8}}\frac{h}{\pi \cdot c \cdot m_0} \cdot \sqrt{\frac{1-\beta^2}{\beta}} \tag{9}$$

Practically, Eq. (9) represents the new equation provided by this study.

Results and Discussion

One will first present the values of the diameter of the nucleus of the first hydrogen isotope, calculated with the old formula (1) in Table 1 and those determined with the new formula (9) in Table 2.

Values are close in the β area = 0.4-1, but much higher for the new formula in the β area = 0-0.4.

The values of the diameter of the nucleus of the second isotope of hydrogen, calculated with the old formula (1) in Table 3 and those determined with the new formula (9) in Table 4 are then presented. The values determined with the two different formulas become closer in the range β = 0.2-1, being different in the first part, of the range β = 0-0.2, where the new formula generates higher values and is much more credible.

Finally, the values of the diameter of the nucleus of the third hydrogen isotope, calculated with the old formula (1) in Table 5 and those determined with the new formula (9) in Table 6 are presented. The values determined with the two different formulas are approximated in the β range = 0.1-1, being different in the first part, of the β range = 0-0.1, where the new formula generates higher values and is much more credible.

Table 1: The proton diameter in the function of β determined with expression (1)

β	0.000009	0.00002	0.0001
D[m]	5.37E-19	4.44E-19	8.90E-20
β	0.001000	0.010000	0.100000
D[m]	3.32E-19	3.33E-18	3.32E-17
β	0.200000	0.300000	0.400000
D[m]	6.58E-17	9.74E-17	1.27E-16
β	0.500000	0.600000	0.700000
D[m]	1.54E-16	1.77E-16	1.94E-16
β	0.800000	0.900000	0.990000
D[m]	2.00E-16	1.82E-16	8.14E-17
β	0.999000	0.999900	0.999990
D[m]	2.84E-17	9.27E-18	2.96E-18
β	0.999999	0.999999	0.999999
D[m]	9.39E-19	2.97E-19	9.40E-20

It is observed that both formulas generate closer results, and the more significant the mass of the particle discussed.

The following masses were used:

m_p = 1.67262192 × 10-27kilograms (mass of a proton)
m_d = 3.3435837724 x 10-27 kg (mass of deuteron)
m_t = 5.0073567446 x 10-27 kg (mass of Triton)

Table 2: The proton diameter in the function of β determined with new expression (9)

β	0.000009	0.00002	0.0001
D[m]	2.21677E-13	1.48706E-13	6.65032E-14
β	0.001000000	0.010000000	0.100000000
D[m]	2.10301E-14	6.64998E-15	2.09247E-15
β	0.200000000	0.300000000	0.400000000
D[m]	1.45701E-15	1.15825E-15	9.63722E-16
β	0.500000000	0.600000000	0.700000000
D[m]	8.14494E-16	6.86842E-16	5.67647E-16
β	0.800000000	0.900000000	0.990000000
D[m]	4.46117E-16	3.05561E-16	9.42869E-17
β	0.999000000	0.999900000	0.999990000
D[m]	2.97486E-17	9.4052E-18	2.97412E-18
β	0.999999000	0.999999900	0.999999990
D[m]	9.40497E-19	2.97411E-19	9.40497E-20

Table 3: The deuteron diameter in the function of βdetermined with expression (1)

β	0.000009	0.00002	0.0001
D[m]	2.87E-19	2.22E-19	4.40E-20
β	0.001000	0.010000	0.100000
D[m]	1.66E-19	1.66E-18	1.66E-17
β	0.200000	0.300000	0.400000
D[m]	3.29E-17	4.87E-17	6.36E-17
β	0.500000	0.600000	0.700000
D[m]	7.72E-17	8.87E-17	9.70E-17
β	0.800000	0.900000	0.990000
D[m]	9.98E-17	9.09E-17	4.07E-17
β	0.999000	0.999900	0.999990
D[m]	1.42E-17	4.64E-18	1.48E-18
β	0.999999	0.999999	0.999999
D[m]	4.69E-19	1.48E-19	4.70E-20

Table 4: The deuteron diameter in the function of β determined with new expression (9)

β	0.000009	0.00002	0.0001
D[m]	1.10894E-13	7.43897E-14	3.32681E-14
β	0.001000000	0.010000000	0.100000000
D[m]	1.05203E-14	3.32664E-15	1.04676E-15
β	0.200000000	0.300000000	0.400000000
D[m]	7.28867E-16	5.79412E-16	4.821E-16
β	0.500000000	0.600000000	0.700000000
D[m]	4.07449E-16	3.43591E-16	2.83964E-16
β	0.800000000	0.900000000	0.990000000
D[m]	2.23169E-16	1.52856E-16	4.71668E-17
β	0.999000000	0.999900000	0.999990000
D[m]	1.48817E-17	4.70493E-18	1.4878E-18
β	0.999999000	0.999999900	0.999999990
D[m]	4.70482E-19	1.48779E-19	4.70482E-20

Table 5: The triton diameter in the function of β determined with expression (1)

β	0.000009	0.00002	0.0001
D[m]	1.85E-19	1.48E-19	3.00E-20
β	0.001000	0.010000	0.100000
D[m]	1.11E-19	1.11E-18	1.11E-17
β	0.200000	0.300000	0.400000
D[m]	2.20E-17	3.25E-17	4.25E-17
β	0.500000	0.600000	0.700000
D[m]	5.15E-17	5.92E-17	6.48E-17
β	0.800000	0.900000	0.990000
D[m]	6.66E-17	6.07E-17	2.72E-17
β	0.999000	0.999900	0.999990
D[m]	9.50E-18	3.10E-18	9.89E-19
β	0.999999	0.999999	0.999999
D[m]	3.13E-19	9.92E-20	3.14E-20

Table 6: The triton diameter in the function of β determined with expression (9)

β	0.000009	0.00002	0.0001
D[m]	7.40475E-14	4.96725E-14	2.22142E-14
β	0.001000000	0.010000000	0.100000000
D[m]	7.02476E-15	2.22131E-15	6.98955E-16
β	0.200000000	0.300000000	0.400000000
D[m]	4.8669E-16	3.86894E-16	3.21915E-16
β	0.500000000	0.600000000	0.700000000
D[m]	2.72068E-16	2.29428E-16	1.89613E-16
β	0.800000000	0.900000000	0.990000000
D[m]	1.49018E-16	1.02067E-16	3.14949E-17
β	0.999000000	0.999900000	0.999990000
D[m]	9.93699E-18	3.14165E-18	9.93453E-19
β	0.999999000	0.999999900	0.999999990
D[m]	3.14157E-19	9.93451E-20	3.14157E-20

A light quantification relation (3) has been also introduced, being necessary to the determination of the structure of hydrogen isotopes. At this point, it will be necessary to demonstrate Eq. (3), the circular impulse (kinetic moment) of the photon, which is a new formula introduced by the author in this paper, practically a new formula of light, system (10). It starts in the system (10) with the equation for conserving the total energy of a photon, where the total energy of the photon ($m_{ph}\cdot c^2$) is equal to the sum of its kinetic energy at linear motion with constant velocity c($1/2m_{ph}\cdot c^2$)and its spin kinetic energy($1/2J_{ph}\cdot\omega_{ph}^2$).From this processed formula, the product($J_{ph}\cdot\omega_{ph}$) is made explicit, which represents exactly the circular (spin) impulse of the photon (or the kinetic moment of the photon), L_{ph}. To obtain the final form, to the expression numerator, the Einstein form of the total energy of a particle ($m_{ph}\cdot c^2$) is replaced by the quantum Einstein form of the total energy of a photon($h\cdot\gamma_{ph}$) and to the expression denominator, the angular velocity of the photon (ω_{ph}) is expressed as a function of its frequency (γ_{ph}), ($\omega_{ph}=2\pi\cdot\gamma_{ph}$).

$$
\begin{aligned}
& m_{ph}\cdot c^2=\frac{1}{2}m_{ph}\cdot c^2+\frac{1}{2}J_{ph}\cdot\omega_f^2\Rightarrow\frac{1}{2}J_{ph}\cdot\omega_{ph}^2=\frac{1}{2}m_{ph}\cdot c^2\Rightarrow\\
& J_{ph}\cdot\omega_{ph}=\frac{m_{ph}\cdot c^2}{\omega_{ph}}\Rightarrow J_{ph}\cdot\omega_{ph}=\frac{h\cdot\gamma_{ph}}{2\pi\cdot\gamma_{ph}}\Rightarrow J_{ph}\cdot\omega_{ph}=\frac{h}{2\pi}\\
& L_{ph}=J_{ph}\cdot\omega_{ph}\Rightarrow L_{ph}=\frac{h}{2\pi}
\end{aligned}
\qquad (10)
$$

The final expression in the system (10) represents exactly the new quantum Eq. (3) introduced in the work for light (photon), being the circular impulse, or the spin impulse of the photon (or the kinetic moment of the photon), which has a quantized constant value ($\hbar = h/(2\pi)$).It is observed that the kinetic moment of a photon is identical to the kinetic moment of the Bohr electron moving in rotation around the nucleus of the hydrogen atom. This is a coincidence that comes to verify the new formula (3) proposed by the author in this paper, which determines the kinetic moment of the photon, which is the same as the circular (rotational) impulse of the photon. Perhaps it would be good to point out here that this kinetic moment of the Bohr electron rotating around the atomic nucleus is known, while the kinetic moment of the photon is not yet known, it is being introduced here by the author for the first time. Physics does not yet know the existence of a kinetic moment at the photon (the rotational impulse of the photon), or simply uses the "linear impulse of the photon"$p_{ph} = h/\lambda_{ph}$, noted with "photon momentum" (OpenStax, 2016). It is good to specify once again that the deduction of the kinetic moment of the photon with the equations of the system (10) was made to obtain an equation or value for L_{ph} (Eq. 3) that can then be equated with the kinetic moment of the elementary particle L_p that associates that photon $L_p = L_{ph}$. In general, however, the kinetic moment of the elementary particle can be equated with the "n" kinetic moments of the associated photon, because several identical photons may contribute to the production of the wave associated with the elementary particle p, $L_p = n\cdot L_{ph}$ (Eq. 4). Today there is the problem of the existence of a magnetic moment of the photon (Pérez Rojas and Querts, 2014), but this is something else entirely.

If one tries to compare the results obtained with the new formula (9) Fig. 1, compared to the old one (1) Fig. 2, it is observed that the variation to the old method is parabolic (bringing far too small values in the first interval, as if the matter would condense even at low speeds), while in the curve described by the new formula (9) Fig. 1, the values of the diameter of the elementary particle in question (here a proton) decrease at first asymptotically, then after a curve close to an arc of a circle and finally after a curve approaching a line. The new method is more credible, because the matter condenses by increasing its energy, mass, or speed, and in no case at low speeds, where the mass is small, the mass of the particle is close to that of the rest mass m_0 andthe energy of the elementary particle is also reduced, due to the small mass and the low speeds with which particles move.

The differences between isotopes can be seen much better in tables than in figures, but they still appear clearly at the transition from the first isotope of hydrogen, the proton, to the third isotope of hydrogen, the triton, so it is worth exemplifying here in the two figures with the diameters of the triton, determined by both methods: (9) in Fig. 3, then the old method (1) in Fig. 4. At proton the values with 10^{-14} obtained by the new method predominate (Eq. 9, Fig. 1) and the values with 10^{-16} obtained by the old method (Eq. 1, Fig. 2), while at triton the values with 10^{-15} predominate when obtained by the new method (Eq. 9, Fig. 3) and the values with 10^{-17} when obtained by the old method (Eq. 1, Fig. 4). The variations between the three isotopes of hydrogen (very close in mass) are difficult to observe from the figures, being easier to follow in the tables, but by switching to the electron diagrams (lighter) the diagrams in the figures will also be able to show the variations by much the ease between the electron (Fig. 5-6) and any hydrogen isotope.

Figure 7 shows the values compared between the two new and old methods for the proton values, then Fig. 8 for those of the deuteron, Fig. 9 for the triton, Fig. 10 for the neutron, and Fig. 11 for the electron.

In Fig. 12, we will compare the values obtained only with the new method (Eq. 9), for proton, neutron, deuteron, triton, and electron, but to highlight the differences better, we will follow the heavier particles alone without electron in Fig. 13.

With the help of the new relationship (9) obtained and presented in the paper, it will be possible to determine with greater precision the size of any hydrogen isotope. It will thus be possible to establish with great precision the speed and energy of the elementary particles necessary for the production and maintenance of controlled nuclear reactions on an industrial scale. Hydrogen is the most widespread element in the entire universe, being spread in about 75% of the mass of the universe and in over 90% of the total number of atoms. In addition, hydrogen is found in large quantities in the composition of gas stars and giant planets. For this reason, H_2 molecular clouds are often associated with star formation. All hydrogen is the key element that plays an important role in stellar explosions (due to nuclear fusion reactions between protons), hydrogen being practically the number 1 energy element in the entire universe. As we pointed out in the introduction to this paper, today there are serious concerns of scientists around the world to obtain hydrogen in industrial quantities by various methods, including bio methods. Hydrogen is then used alone or in convenient compounds to obtain energy by burning it. If hydrogen is burned alone, clean energy and water are obtained, without toxic carbon oxides (which result from the combustion of hydrocarbons or carbides). However, obtaining massive energy on an industrial scale forces us to follow the example of the energy given by hydrogen throughout our universe, especially in stars, ie it's fusion energy. All the first three isotopes of hydrogen (Protium, Deuterium, and Triton) can generate energy on an industrial scale through nuclear fusion reactions. Generally, in stars, these nuclear fusion reactions occur due to the huge temperatures inside a star, but also the very high pressures there. Since the 1980s, scientists have been making enormous efforts to be able to develop controlled nuclear fusion reactions with a convenient and industrial-scale yield. Obtaining huge star-like temperatures in nuclear reactors is very difficult and maintaining these temperatures for long periods is also very difficult. However, after about 40 years of work, there is remarkable progress in this field that gives us hope for the achievement of the nuclear fusion of hydrogen isotopes shortly. A separate method of cold nuclear fusion has also been successfully tested recently, using accelerated hydrogen isotopes. For this purpose, these isotopes are ionized so that the atoms are transformed into nuclei (by losing electrons), becoming positive ions that can be easily accelerated in modern particle accelerators. Today, there are also tests by combined methods, i.e., a fusion performed hot but still with ions accelerated to the optimal energy required to perform the fusion with a convenient efficiency. In all these situations, the acceleration energy of the hydrogen isotope ions used must be known with great precision and the necessary calculations also require precise knowledge of the size of these ions. This is where the new relationship (9) introduced in the paper probably intervenes successfully to determine the diameters of the nuclei of hydrogen isotopes depending on their energy (or their speed).

It should be noted again that Eq. (9) could be deduced in the paper with the help of two important hypotheses regarding the conservation of the impulses of the moving elementary particle. If de Broglie intuited the conservation of the linear impulse of the moving elementary particle (its equality with that of the associated photon, or associated wave), the introduction in the paper and the conservation of the rotational impulse of the elementary particle (spin impulse), i.e., the equality of the spin impulse of the elementary particle in motion with the spin impulse of the associated wave photon, could superiorly solve the mathematical problem of the general quantum system of an elementary particle in motion. The author took the idea from Dane Niels Bohr, who used this conservation of the rotational impulse of the electron in the orbit of the atom or around the atomic nucleus, to demonstrate the quantum character of the motion of the atomic electron in its orbit.

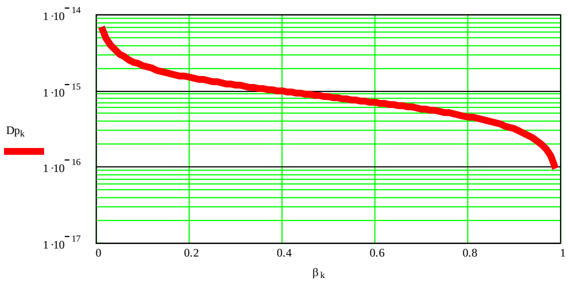

Fig. 1: The values Dp (in meters) of the diameter of the elementary particle in question (here a proton) decrease at first asymptotically, then after a curve close to an arc of a circle, and finally after a curve approaching a line, depending on the beta (Obtained with the new Eq. 9)

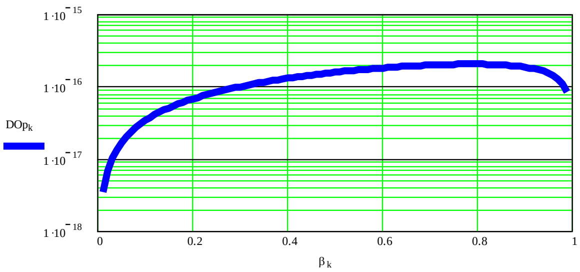

Fig. 2: The values Dp1 (in meters; or DpOld) of the diameter of the elementary particle in question (here a proton) the variation to the old method is parabolic, depending on the beta (Obtained with the old Eq. 1)

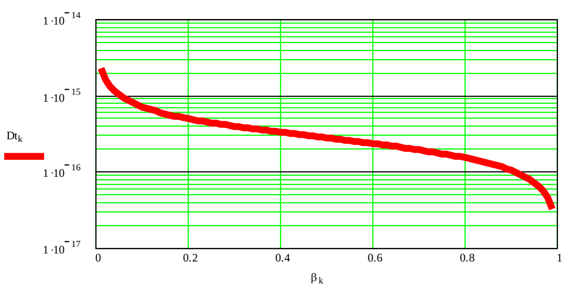

Fig. 3: The values Dt (in meters) of the diameter of the elementary particle in question (here a triton), depending on the beta (Obtained with the new Eq. 9)

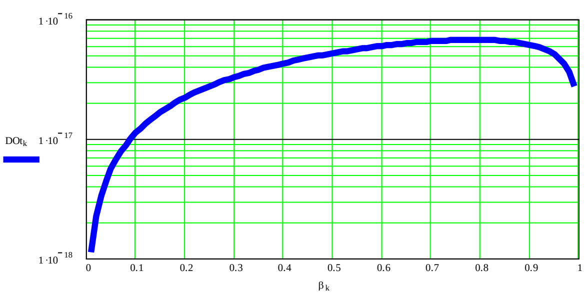

Fig. 4: The values Dt1 (in meters) of the diameter of the elementary particle in question (here a triton), depending on the beta (Obtained with the old Eq. 1)

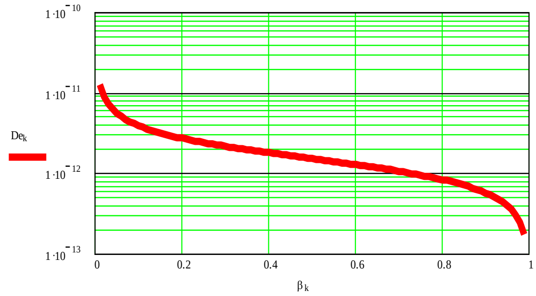

Fig. 5: The values De (in meters) of the diameter of the elementary particle in question (here an electron), depending on the beta (Obtained with the new Eq. 9)

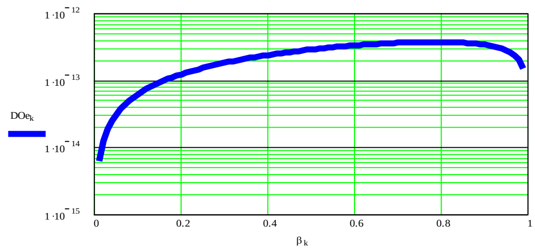

Fig. 6: The values D1e (in meters; or D**O**[ld]**e**) of the diameter of the elementary particle in question (here an electron), depending on the beta (Obtained with the old Eq. 1)

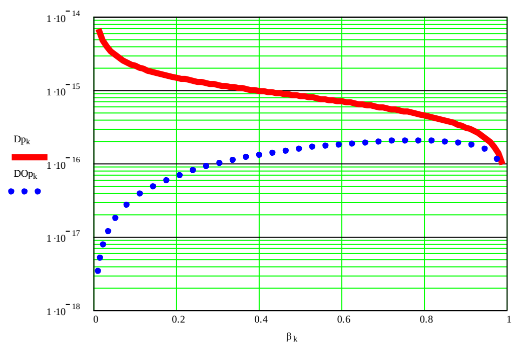

Fig. 7: Values compared between the two new (red) and old (blue) methods for the proton values

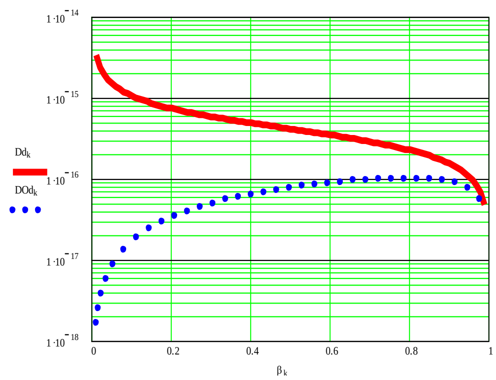

Fig. 8: Values compared between the two new (red) and old (blue) methods for the deuteron values

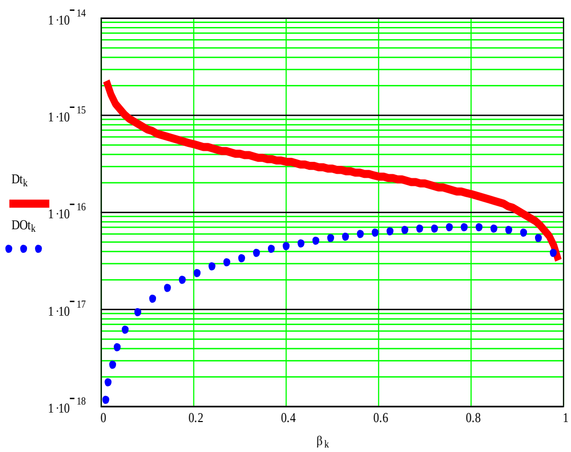

Fig. 9: Values compared between the two new (red) and old (blue) methods for the tritium values

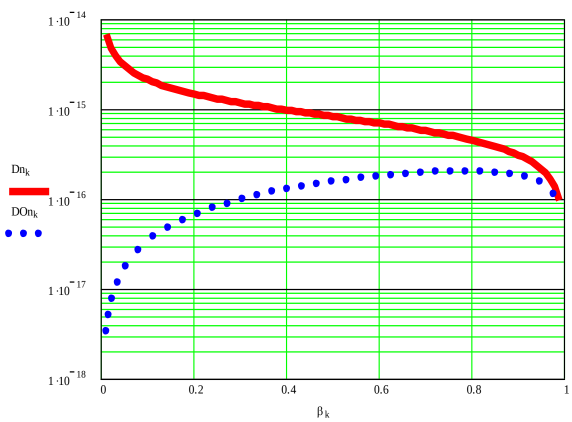

Fig. 10: Values compared between the two new (red) and old (blue) methods for the neutron values

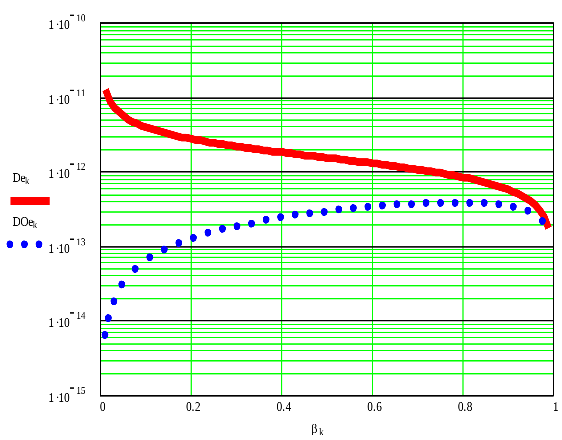

Fig. 11: Values compared between the two new (red) and old (blue) methods for the electron values

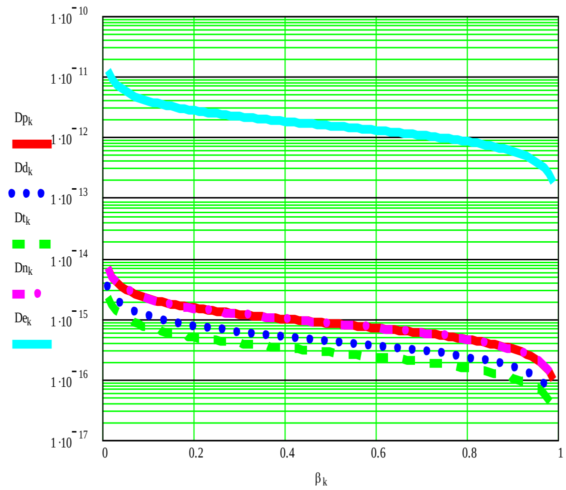

Fig. 12: Compare the values obtained only with the new method (Eq. 9), for proton, neutron, deuteron, triton, and electron

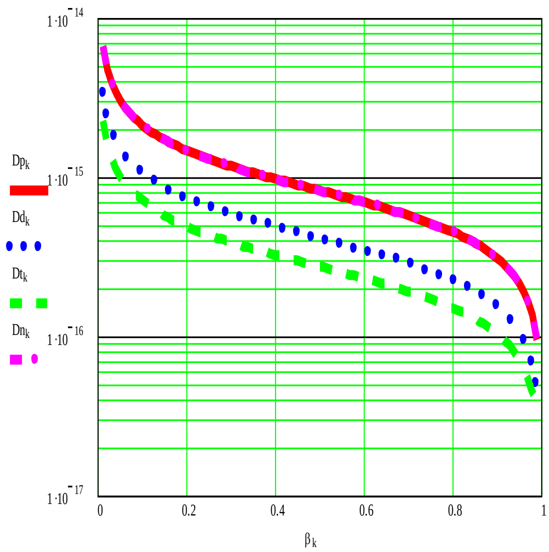

Fig. 13: Compare the values obtained only with the new method (Eq. 9), for proton, neutron, deuteron, and triton

Theory and Results Validation

The values of the diameters of hydrogen isotopes depending on their energy (mass or velocity), obtained with the new theory and the new Eq. (9) introduced in the paper are much closer to what is known today for the entire field of β ratio. However, for better verification of the new Eq. (9) presented, even if it is not the subject of the paper (proposed by the title of the paper), the values of the dimensions of an electron (positron) will be presented according to its energy (velocity v, or more precisely depending on the β ratio between its speed v and the speed of light in a vacuum c). In Fig. 5 one can follow the values of the Diameter (D2) of the moving electron according to the β ratio, obtained with the new Eq. (9).

All measurements, old (Niels Bohr, 1913a-b; Halliday and Robert, 1966) and new (Hydrogen Encyclopedia, 2021), indicated for a static atom (so at low speeds, or for a low β ratio) diameter of the hydrogen atom (first its isotope, protium) between $2 \cdot 10^{-10}$ and $6 \cdot 10^{-10}$ meters and classically, the electron has a diameter between 10^{-11} and 10^{-12} meters (Halliday and Robert, 1966) and more new, the electron has a diameter bigger than 10^{-12} meters (Brian, 2015), exactly as indicated by the values in Fig. 5 (left side), the values in Fig. 6 being much smaller (from 10^{-13} to 10^{-17} meters). In a paper (Brian, 2015) it is logically indicated that the radius of the electron must be less than its wavelength: $r_e<\lambda=h/(m_e \cdot c)=2.42622E^{-12}$ (meters) => $d_e < 1.2E^{-12}$ (meters) => d_e is between 10^{-11} and 10^{-12} meters.

Going further with the verification according to the same logical criterion (Brian, 2015), that indicates that the radius of an elementary particle must be greater than its wavelength, the wavelengths at the three isotopes of hydrogen will be further calculated.

For protium (proton): $r_p<\lambda=h/(m_p \cdot c)=1.32E^{-15}$ (meters) => $d_p < 2.64E^{-15}$ (meters).

And $d_p=2.64E^{-15}$ meters from Table 2 andFig. 1, when β=0.07.

For deuterium (deuteron): $r_d<\lambda=h/(m_d \cdot c)=6.61E^{-16}$ (meters) => $d_d<1.32E^{-15}$ (meters). And $d_d=1.32E^{-15}$ meters from Table 4 andFig. 3, when β=0.08.

For tritium (triton): $r_t<\lambda=h/(m_t \cdot c)=4.41E^{-16}$ (meters) => $d_t < 8.83E^{-16}$ (meters).

And $d_t=8.83E^{-16}$ meters from Table 6 andFig. 5, when β=0.08.

Discussion

In mechanical physics, the following quantities are conserved: Total Energy E), Kinetic Energy (Ec), Forces (F), Moments (M), Powers (P), Kinetic Momentum (L), and Linear Impulse (p). All are vector quantities except energies and for this reason, they can be used either vectorially or as scalars. In addition, it must be specified that the kinetic moment is the same thing as the rotary impulse (Eq. 11).

$$\begin{aligned}\vec{L} &= \vec{r} \times \vec{p} = \vec{r} \times (m * \vec{v}) = m * (\vec{r} \times \vec{v}) = m * (\vec{r} \times \vec{\omega} \times \vec{r}) \\ &= m * r^2 * \vec{\omega} = m * r^2 * \omega * \vec{e}_L = J * \vec{\omega}\end{aligned} \tag{11}$$

It is easy to see that the Kinetic Momentum L, which is defined as the vector product between the distance vector r and the linear momentum (vector) p, is finally reduced to the circular momentum (rotary impulse) vector L = J.ω, where L is a vector, ω is a vector and represents the angular speed of rotation [in Hz] and J is the rotating mass of the element (body, particle) in motion (a scalar quantity) and is measured in [$kg \cdot m^2$]. Because here the vector quantities used in the work, p and L, which are conserved, have in both versions, before and after conservation, the same direction and sense, they can be used as scales.

Another important observation is that although the kinetic moment (*or rotary impulse*) L, contains within its framework the linear impulse p, nevertheless L is something other than p. The conservation of the two quantities L and p, being used in this study simultaneously, for obtaining the new dynamic Eq. (9). Conservation of linear momentum p was first successfully used by de Broglie (de Broglie, 1923), and conservation of circular momentum L (otherwise known as Kinetic Momentum) was first successfully used by Niels Bohr (1913a-b).

The original dynamic Eq. (1) was made possible by combining the conservation of energy and linear momentum p and the new Eq. (9) proposed by the paper was obtained by adding to the conservation of energy and linear momentum p and the conservation of *circular momentum* L.

Another important observation is that although quantum mechanics was born with the hypothesis of the conservation of kinetic momentum of Bohr in his atomic model, in reality, the quantization comes from Plank's constant h, which together with the conservation of linear or circular momentum can introduce the natural number n, as an amplification factor of h, if we consider the photonic particle associated with an elementary particle in motion, as it could be one or even more (n) photonic associated particles.

The calculation program and all figures were performed and simulated in Mathcad.

Conclusion

Hydrogen is the key energy element in our universe, but also in our inner universe. Under these conditions, it is normal to make hydrogen the number 1 element of industrial energy, as it was constituted in living matter as the number two energy element, immediately after oxygen and together with nitrogen and phosphorus.

The paper introduces an original physical-mathematical equation with the help of which the dimensions of the moving elementary particles can be determined with precision. The original Eq. (9) allows the precise mathematical calculation of the radius of an elementary particle in motion, which leads to the possibility of its use in various physical-mathematical and chemical applications and various industrial processes. One of its first applications is the precise determination of the energy of accelerated elementary particles to initiate and maintain controlled nuclear fusion reactions at an optimal yield.

This opens up new perspectives in nuclear physics and nuclear energy, but also in the sciences of living energy, where hydrogen plays an essential energy role alongside three other vital energy elements, oxygen, nitrogen, and phosphorus.

In 2019 the author has already introduced such an Eq. (1), but that equation had some problems in the area of low velocities, where it theoretically generates an unexpected condensation of matter similar to that which occurs with increasing kinetic energy of a particle. The new theory with the new Eq. (9) introduced in the paper remedies this undesirable aspect, following only the condensation of the natural elementary matter, only with the increase of the kinetic energy of the respective elementary particle.

The dimensions of the hydrogen isotopes are more normal in the version of the new theory (range of values $10^{-13} \dots 10^{-20}$) than those in the version of the old theory of the author (where the range of values was $10^{-16} \dots 10^{-20}$).

It should also be noted that in the Bohr quantification equation the real quantification factor is Planck's constant h (before the quantum number n). The same constant h is the one that quantifies light in Planck's and Einstein's equations ($E = h \cdot \gamma$). And Planck's constant h also brings the quantum aspect in both new equations presented in this study.

The paper also introduces a new Eq. (3) of the kinetic moment of a photon, unknown until today, its introduction and deduction (with system 10) being processed to use this new Eq. to calculate the main new Eq. (9) proposed by the paper.

Acknowledgment

The author acknowledges INIS for his research in the field.

Funding Information

The authors have not received any financial support or funding to report.

Ethics

This article is original and contains unpublished material. The author declares that are no ethical issues and no conflict of interest that may arise after the publication of this manuscript.

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Nomenclature

h	=>	The Planck constant: h=6.626 E-34 [Js]
q	=>	Electrical elementary load: qe=-1.6021 E-19[C] qp=+1.6021 E-19[C]
c	=	The light speed in vacuum: c=2.997925 E+08 [m/s]

The permissive constant (the permittivity):

$$\varepsilon_0 = 8.85418 \cdot 10^{-12} \left[\frac{C^2}{N \cdot m^2} \right]$$

n	=	The principal quantum number (the Bohr quantum number);
Z	=	The number of protons from the atomic nucleus (the atomic number);
m0[kg]	=>	The rest mass of one particle
m0electron	=	9.11E-31 [kg]
m0proton	=	1.672621898(21) E-27 [kg]
m0neutron	=	1.674927471(21) E-27 [kg]
m0deuteron	=	3.34449 E-27 [kg]
m0triton	=	5.00827 E-27 [kg]