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Elementary Structure of Matter can be Studied with New Quantum Computers

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Abstract: Much has been talked about quantum computers. Today they are working on difficult simulations, so we can already congratulate the college of researchers at the Oak Ridge National Laboratory as the world's first to successfully simulate an atomic nucleus using a quantum computer. The results that were published in the physical examination letters demonstrate the huge capacity of quantum systems to calculate the problems of nuclear physics and to be able to be successfully used in the future for special and complex simulations. It is already known that quantum calculus, which is based on the quantum principles of matter and which was proposed by American physicist Richard Feynman in the early 1980s, unlike the ordinary bits of normal computers today, uses the qubit units used by quantum computers to store information in two-state systems, such as electrons or photons, considered simultaneously in all possible quantum states (essentially a phenomenon known as overlapping). In October 2017, a multidisciplinary ORNL team began working on codes to perform various simulations on quantum computers such as IBM QX5 and Righetti 19Q within a DOE Quantum Testbed Pathfinder project in an effort to verify and validate various scientific applications on different types of quantum hardware. Today, quantum computers have potential applications in cryptography, artificial intelligence and weather forecasting, as each additional qubit clings in some way inextricably from the others, thus exponentially increasing the number of possible results for the final measured state. Obviously, this huge benefit also has negative effects on the system, because errors can in turn exponentially increase the size of the problem and the final results even. However, it is hoped that in the future on the basis of much-improved hardware, researchers will be able to solve problems that cannot be solved today using current calculation methods. In the present paper the authors propose an original method of rapid theoretical determination with great precision of the dimensions of all elementary particles, the method which, although predicting results similar to those obtained by other theoreticians, still has the advantage of its simplicity, of its general applicability, that is of its universality and especially this new method is a precious tool in the work of scientists worldwide to understand matter at its elementary level. Even though we would have expected that the size of a deuteron would be larger (double) than that of one component particle (of a proton or neutron), at the same velocity, the theory (20-21) demonstrates the opposite. By fusing two free nucleons, a proton and a neutron, a deuterium nucleus is obtained with smaller dimensions than its two components, which makes the energy of rejection between two Deuteron cores much larger than we would have waited. That's why the fusion reaction between two Deuterons is even more difficult than was suspected, even when they are accelerating.

Keywords: Matter Structure, Elementar Particle Structure, Quantum Machines

Introduction

A quantum computer uses quantum mechanics to solve specific problems, such as decrypting encryption keys used in secure Internet communication (SSL) over the Internet through the HTTPS protocol.

Deciphering keys used in secure communication is very difficult, ranging from days for 128-bit keys, up to 3 months for 768-bit keys (see Conclusions), using about 100,000 tandem computers, or up to 4,294,967,296 x 1.5 million for 2048 bit keys.

Quantum computers can be used by a special algorithm called Shor, which can reduce decryption times from months or years to just seconds or minutes. The secret is not the speed with which the operations are done, but the fact that those quantum computers need fewer steps than the classical computers to make a calculation.

In simple operations, such as watching a movie or listening to a song, a quantum computer would be as fast as today, but success is seen in specific applications, which is why quantum computers are not seen as the rival of classical, but only as complementary machines.

Quantum computers use the fact that qubits can have state 0 and state 1 at the same time (i.e., a superposition), while a classical bit can either have a value of 0 or a value of 1. Since superpositions cannot be measured, a series of logical operations leading to a measurable result.

Superposition is due to the phenomenon called quantum entanglement, a phenomenon that creates a bond between several particles by contacting them. Once that bond has been created, the change in the state of one of the particles will change the state of the other particle even if the second particle has been moved to an infinite distance. The change will be instantaneous regardless of the distance to which the second particle is. Quantum mechanics is weird.

If we want to find out which of the numbers 00, 01, 10, 11 is in the computer, then a classic computer uses two bits to give the result. The two bits offer two numbers, 0 and 1, but two qubits will contain 4 numbers. The amount of information contained in qubit will be equal to 2^n bits.

In other words, in simpler terms, how can electrons or nuclei of atoms be manipulated to use them as qubits. Qubits are the basic units of information stored in a quantum computer. Generally, electrons or nuclei of atoms will be used as qubits. In one of the recent experiments made in Australia inside a classical transistor, a phosphorus atom is inserted and the electron on the upper layer was used as a qubit.

One of the properties of electrons or atomic nuclei is the magnetic spin, an intrinsic property of them, very similar to the electric charge of an electron, for example. Well, that magnetic spin has two states, "up" and "down", which can be manipulated by using radiation.

It is the application of precise frequency radiation to change the spin of the electron or nucleus. Once changed, that spin stays in the same position for a long time (it is assumed to be an infinite number of years, so it can be used as a memory device).

Installations that bring the temperature of the atoms very close to absolute zero are used, after which the electron is placed in a very strong magnetic field and then used by microwaves at the frequency of 45.02 GHz to change its spin. The spin of a nucleus can be changed using microwaves at 44.9 GHz.

No, not like the microwaves in our home, which operates at 2.5 GHz, so we have some qubits go if we heat food in the microwave.

It must be taken into account that the microwave frequency required to change the spin of an electron depends on the magnetic field in which that electron is located.

Much has been talked about quantum computers. Today they are working on difficult simulations, so we can already congratulate the college of researchers at the Oak Ridge National Laboratory as the world's first to successfully simulate an atomic nucleus using a quantum computer. The results that were published in the physical examination letters demonstrate the huge capacity of quantum systems to calculate the problems of nuclear physics and to be able to be successfully used in the future for special and complex simulations.

It is already known that quantum calculus, which is based on the quantum principles of matter and which was proposed by American physicist Richard Feynman in the early 1980s, unlike the ordinary bits of normal computers today, uses the qubit units used by quantum computers to store information in two-state systems, such as electrons or photons, considered simultaneously in all possible quantum states (essentially a phenomenon known as overlapping).

If classical bits are used in bits of zero and one, Thomas Papenbrock, a theoretical physicist at the University of Tennessee and ORNL, who coordinated the project with the ORNL quantum intelligence expert Pavel Lougovski, informed us in the quantum calculations that use a qubit can have zero, one and any possible combination of zero and one, so as to obtain a much more complex set of data storage capabilities.

In October 2017, a multidisciplinary ORNL team began working on codes to perform various simulations on quantum computers such as IBM QX5 and Righetti 19Q within a DOE Quantum Testbed Pathfinder project in an effort to verify and validate various scientific applications on different types of quantum hardware. The free pyQuil software, which is a specific electronic library designed to produce and manage different quantum training programs, has been used. In this way, the researchers could write a special code that was first sent to a simulator and then to the cloud-based IBM QX5 and Righetti 19Q systems.

The essential part of the experiment was to perform several measurements (about 700,000 quantum measurements) of deuterium, proton nucleus (deuteron) and especially of neutron energy. On this occasion, based on the measurements made, the team could extract the energy of binding the deuteron, the minimum amount of energy needed to disassemble in these subatomic particles. In this experiment, Deuteron is the simplest nucleus of the nuclear compound, becoming an ideal candidate for the project.

"Qubits being some generic versions of quantum systems with two states basically do not possess neutron or proton properties," Lougovski told us. "So we can first map these properties to qubits so that they can then be used to simulate specific phenomena - such as in this case, the mandatory energy."

A great challenge when working with such quantum systems is that researchers first have to run various simulations at a distance and then wait for the results and the working time is higher. Alex McCaskey and the quantum researcher Eugene Dumitrescu have made some individual measurements of 8,000 times each, in order to ensure the statistical accuracy of the obtained results.

"It's difficult to do that on the net," McCaskey said. "This algorithm was mainly built by hardware vendors themselves because only they can actually access the computing machine."

The team also found that quantum devices are difficult to use due to chip noise, which can drastically alter the results of the scientific experiment, which is why it has been necessary to repeat it so many times. McCaskey and Dumitrescu have been able to create strategies to reduce high error rates, such as artificially adding more simulations just in order to see the impact and to infer what could be the result of zero noise, precisely because:

"These systems are truly susceptible to noise," said Gustav Jansen, a scientist at OLCF's Scientific Computing Group, a DOE office at the ORNL Science Office. "When particles enter the quantum calculus, they can really change the measurements, so these systems are not perfect, but during their work, we try to better understand the intrinsic errors."

With the completion of this quantum project, it was checked whether the results obtained were in the classical beach of classical measurement methods and it was found that the results of the qubite team were in a range of 2 and 3% compared to the correct answer given by a classical computer, so that this quantum calculation has become the first of its kind in the nuclear physical community.

The importance of these first simulations is great, opening up new research paths, new possibilities for scientific experimentation to calculate heavier nuclei

that have more protons and neutrons with quantum systems in the future.

Today, quantum computers have potential applications in cryptography, artificial intelligence and weather forecasting, as each additional qubit clings in some way inextricably from the others, thus exponentially increasing the number of possible results for the final measured state. Obviously, this huge benefit also has negative effects on the system, because errors can in turn exponentially increase the size of the problem and the final results even.

However, it is hoped that in the future on the basis of much-improved hardware, researchers will be able to solve problems that cannot be solved today using current calculation methods (Dumitrescu *et al.*, 2018).

Materials and Methods

In other papers, one has shown that in general the matter at its elementary level has been studied statically and not dynamically in motion, as it is in reality, for which the theoretical and sometimes experimental errors were very high in relation to the lying dimensions (Halliday and Robert, 1966). The real dimensions of the elementary particles in permanent motion (which, depending on the particle, may be of the order of Nano, Pico or even smaller) are very difficult to determine both experimentally and theoretically even today when we have many characterization tools sophisticated (atomic force microscopes, Nanoindenter, etc.). In these dynamic conditions, it is important to determine the real dimensions of an elementary moving particle, which gives a particular complexity to both theoretical and experimental enterprises (Petrescu and Calautit, 2016a; Petrescu *et al.*, 2016 a-c).

And for photons, moving at the speed of light, a special method of determining their dimensions was presented based on the specific electromagnetic wave frequency associated with the photon in question, occasionally introducing a new equation of light movement, in addition to the two existing ones, both due to the great scholar Einstein (Petrescu and Calautit, 2016b).

To begin with, we want to present the theoretical principles necessary to determine the exact magnitude of an electron in motion according to its specific displacement velocity.

Relationship 1 can accurately determine the radius of the moving electron R , depending on the velocity v and the resting mass m_0 . The speed of light in a vacuum is expressed with c and Planck's constant with h (Planck, Wikipedia):

$$R = \sqrt{\frac{10}{8}} \cdot \frac{h \cdot \sqrt{c^2 - v^2} \cdot \sqrt{c^2 - \frac{v^2}{2}} - c \cdot \sqrt{c^2 - v^2}}{\pi \cdot m_0 \cdot c^2 \cdot v} \quad (1)$$

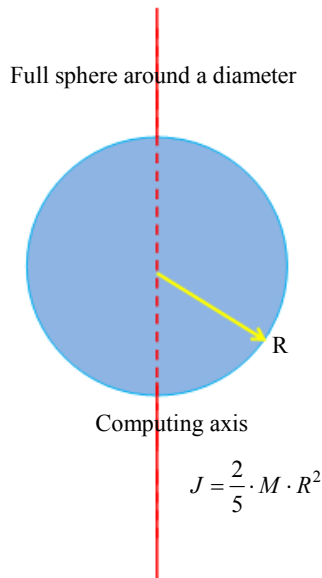


Fig. 1: Mass moment of inertia to a full sphere, determined around its symmetry axis

Mechanical moment of inertia of a sphere around of one of its axes could be determined by using the relationship 2 (Fig. 1), (Petrescu, 2012; Mirsayar *et al.*, 2017):

$$J = \frac{2}{5} m \cdot R^2 \quad (2)$$

The mass of an electron in motion can be determined then according to its speed and its rest mass using re-handled Lorentz expression 3 (Lorentz, Wikipedia):

$$m = \frac{m_0 \cdot c}{\sqrt{c^2 - v^2}} \quad (3)$$

The electron (like any elemental mobile particle) has two types of motion, one translated and one that rotates around its own axis. These two movements are consistent with the two kinetic energies (the energy due to the movement of the translation electron on its trajectory and the energy due to the rotation of the electron around the axis of the diameter); expression 4 shows the total kinetic energy of a moving electron as sum of the two components (translational and rotational):

$$E_c = \frac{1}{2} m \cdot v^2 + \frac{1}{2} J \cdot \omega^2 \quad (4)$$

Using the two expressions 2 and 3, the relationship 4 takes the below forms 5:

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

One uses the expression 6 to write the particle pulse:

$$p = m \cdot v = \frac{m_0 \cdot c \cdot v}{\sqrt{c^2 - v^2}} \quad (6)$$

Using the theory of Louis de Broglie (de Broglie, Wikipedia), which describes the conservation of the pulse the wavelength particle associated may be calculated using relationship 7:

$$\lambda = \frac{h}{p} = \frac{h \cdot \sqrt{c^2 - v^2}}{m_0 \cdot c \cdot v} \quad (7)$$

Wave frequency (associated with the electron in motion) can be then determined using the relationship 8 (Halliday and Robert, 1966):

$$\gamma = \frac{c}{\lambda} = \frac{c \cdot m_0 \cdot c \cdot v}{h \cdot \sqrt{c^2 - v^2}} = \frac{m_0 \cdot c^2 \cdot v}{h \cdot \sqrt{c^2 - v^2}} \quad (8)$$

The angular electron speed and its square are calculated using the expressions 9:

$$\begin{cases} \omega = 2\pi\gamma = \frac{2\pi \cdot m_0 \cdot c^2 \cdot v}{h \cdot \sqrt{c^2 - v^2}} \\ \omega^2 = \frac{4\pi^2 \cdot m_0^2 \cdot c^4 \cdot v^2}{h^2 \cdot (c^2 - v^2)} \end{cases} \quad (9)$$

Considering expressions 9, expressions 5 may be written in the following expressions 10:

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

Moving electron kinetic energy may be calculated through the expression 11 by subtracting the total electron rest energy from total electron energy in movement:

$$\begin{aligned} E_c &= E - E_0 = m \cdot c^2 - m_0 \cdot c^2 = \\ &= m_0 \cdot c^2 \cdot \frac{c \cdot \sqrt{c^2 - v^2}}{\sqrt{c^2 - v^2}} \end{aligned} \quad (11)$$

$$\left\{ \begin{aligned} & \frac{1}{2} \frac{m_0 \cdot c \cdot v^2}{\sqrt{c^2 - v^2}} \cdot \left[1 + \frac{8}{5} R^2 \cdot \pi^2 \frac{m_0^2 \cdot c^4}{h^2 \cdot (c^2 - v^2)} \right] = \\ & = m_0 \cdot c^2 \cdot \frac{c - \sqrt{c^2 - v^2}}{\sqrt{c^2 - v^2}} \\ & R = \sqrt{\frac{10}{8}} \cdot \frac{h}{\pi \cdot m_0 \cdot c^2} \cdot \frac{\sqrt{c^2 - v^2} \cdot \sqrt{c^2 - \frac{v^2}{2}} - c \cdot \sqrt{c^2 - v^2}}{v} \\ & R = \sqrt{\frac{10}{8}} \cdot \frac{h \cdot \sqrt{c^2 - v^2} \cdot \sqrt{c^2 - \frac{v^2}{2}} - c \cdot \sqrt{c^2 - v^2}}{\pi \cdot m_0 \cdot c^2 \cdot v} \end{aligned} \right. \quad (12)$$

Results

By considering the two expressions 10 and 11 and combining them, the first term of relationships 12 is obtained, which represent the expression to evaluate the radius of an electron in movement. The second term from in Equation 12 is the initially mentioned relation 1:

By using Equation 1, the radius of any elementary moving particle can now be calculated. Table 1 shows the radius of a moving electron (calculated with Equation 1) according to β (β being the ratio between v and c , expression 13):

$$\beta = \frac{v}{c} \quad (13)$$

Using the original method proposed by the authors, the moving electron beam can be determined with great precision, depending on the speed at which it moves. From the results presented in Table 1 it can be observed that the electron has no constant radius.

The electronic phase depends primarily on the speed of movement and, secondly, on the resting table.

From the table shown, the average radius of an electron 1.09756E-13 [m] and a maximum electronic value of 1.83152E-13 [m] corresponding to a $\beta = 0.8$ can be determined.

Table 1: The electron radius in function of β

b	0.000009	0.00002	0.0001
R[m]	4.93E-16	4.07E-16	8.15E-17
b	0.001	0.01	0.1
R[m]	3.05E-16	3.05E-15	3.04E-14
b	0.2	0.3	0.4
R[m]	6.04E-14	8.94E-14	1.16E-13
b	0.5	0.6	0.7
R[m]	1.41E-13	1.62E-13	1.78E-13
b	0.8	0.9	0.99
R[m]	1.83E-13	1.66E-13	7.47E-14
b	0.999	0.9999	0.99999
R[m]	2.61E-14	8.51E-15	2.71E-15
b	0.999999	0.9999999	1
R[m]	8.62E-16	2.72E-16	8.63E-17

The minimum radius value (in real cases) is about 8.15E-17 [m], but may decrease more when the limits are reached.

Electrons that normally move at low speeds of about 0.01c will have a range of 3.05E-15 [m]. Only this value can be found using classical relationships already known.

Discussion

In this study, the theoretical principles necessary to determine the exact magnitude of a moving electron, depending on the speed of movement, will be exposed.

The equations are specifically discussed to determine the radius R of the moving electron, which refers to the electron movement velocity v and the resting mass m_0 .

The mechanical moment of inertia of a sphere around one of its diameters is determined by the relationship between the total kinetic energy of a moving electron as the sum of the two components (translatable and rotating).

Using the theory of Louis de Broglie, which shows impulse preservation, the wavelength (associated with the particle) was calculated.

The frequency of the waves (associated with the moving electrons) was determined and the moving electronic kinetic energy was estimated by decreasing the total resting energy of the electron from the total energy of the moving electrons.

As far as we know, basic matter consists of quarks and leptons. Quarks combine to form hadrons, mainly baryons and mesons, with strong force and are supposed to be still well isolated.

Among the baryons are the proton (positive electric charge) and the neutrons (with zero electrical charge) that they combine to form the atomic nuclei of all the chemical elements of the periodic table.

Normally, an electron core (the negative electrical charge and the opposite of the proton) surrounds these nuclei. The cluster consisting of a nucleus and a cloud, containing negative electrons and positive protons, is an atom. Atoms can be arranged together to form larger and more complex structures, such as molecules.

Chemistry is a science that describes how nuclei and electrons are combined to form different elements and molecules.

In a more cosmological view, matter and antimatter are taken into account. Each sub-particle of an atom can be counterbalanced by a pair (anti-) antimatter (e.g., electron-positron).

An antimatter particle differs from its partner in that its different "fillings" (electrical charge, rotation, color loading, etc.) are opposite. However, these particles have the same mass.

Although the fundamental laws of physics do not indicate a preference for matter over antimatter, cosmological observations show that the universe consists almost entirely of matter.

The material can be found in several states or phases. The four most well-known states are solids, liquids, gases and plasma. There are other less exotic states, such as liquid crystal, Bose-Einstein, superfluid and supercritical fluid (Bose-Einstein, Wikipedia). When the material passes from state to state, it performs a phase transition. This phenomenon (which is associated with changes in physical parameters: Pressure, temperature, volume, density, energy, etc.) is studied in thermodynamics by phase diagrams.

When more particles combine to form atoms, the total mass of the body is less than the sum of the masses (at rest), because, in fact, part of the weight of the components converts the binding energy, it is necessary to ensure that the group of phenomena is reported as a "massive defect"). By speculating this defect, nuclear fusion energy is extracted.

The electron, one of the particles of the atom having an elementary charge of the negative sign, is fundamental in chemistry because it participates in almost all types of chemical reactions and is a key element of the chemical bond of matter. In physics, on the other hand, the electron is involved in a multitude of phenomena related to the effects of radiation.

Electromagnetic induction, luminescence, magnetism, electromagnetic radiation, optical reflection and large macroscopic super conduction exploited in industrial applications (Cherenkov, Wikipedia) explain the electrical characteristics exhibited at the atomic level. In addition, the electron with the smallest mass in comparison to any other charged particles is regularly used in the study of matter.

All these theories lead to applications in aerospace and robotics for aerospace (Petrescu *et al.*, 2017 a-ae; 2018 a-i).

Case II, Deuteron

Deuterium (with the symbol D or $2H$, also known as heavy hydrogen) is one of the two stable isotopes of hydrogen together with the protium. The first isotope of hydrogen is the atom called the counter, which contains a single nucleus in the nucleus, namely a single proton. As the (positive) ion, when you lose the electron, the atom or isotope of the counter is a positive ion, a simple proton known as a proton. Protium, as well as its proton ion, are extremely stable elements. Initially, it was desired to perform a nuclear fusion reaction between two opposites (isotopes), as happens in stars, but because of the very high anus stability, the fusion reaction requires energy and a high temperature to achieve it. The conditions in the stars are extremely difficult to achieve on Earth. Then it was just as natural for the next hydrogen isotope, the second, namely deuterium. The deuterium core, called deuteron, contains a proton and a neutron, while the much more common isotope of hydrogen is not a neutron in the nucleus.

Deuterium has a natural abundance in the Earth's oceans of about one hydrogen atom in 6420. Thus, deuterium represents about 0.0156% (or 0.0312% by mass) of the total hydrogen in the ocean, while the most common isotope Hydrogen-1 (or protium) represents more than 99.98%. The abundance of deuterium changes easily from one kind of natural water to another (see the average ocean Mean Ocean Water in Vienna). The name of the deuterium isotope is made up of the Greek deuterios, which means "the second" to designate the two particles that make up the nucleus. Deuterium was discovered and named in 1931 by Harold Urey. When the neutron was discovered in 1932, this made the structure of nuclear deuterium obvious and Urey won the Nobel Prize in 1934 for this discovery. Shortly after detecting deuterium, Urey and others could produce "heavy water" samples in which deuterium content was highly concentrated. In this way, deuterium has become a raw material immediately available from the water, turning it into heavy water. If we succeed in the deuterium fusion process, the necessary fuel, heavy water can be obtained very simply with the current technologies in unlimited quantities, quite cheap. The nuclear fusion reaction having deuterium as fuel is simpler on earth than the one using the protium, since deuterium, albeit very stable, is more unstable than that of the protium. Nuclear fusion can be facilitated between two more unstable nuclei. In the fusion processes in stars, deuterium is destroyed inside stars faster than it is produced. It is believed that other natural processes produce only an insignificant amount of deuterium. Almost all forms of deuterium found in nature were produced in the Big Bang 13.8 billion years ago because the natural or primary ratio of hydrogen-1 (protium) and hydrogen-2 (deuterium) (which is about 26 of deuterium atoms to one million hydrogen atoms) originates at that time (Big Bang). As evidence, this is the ratio found in giant gas planets such as Jupiter. However, it is found that other astronomical organisms have different ratios of deuterium-hydrogen-1. It is believed to be the result of natural processes of separating isotopes from the sun's comets to comets. Like the cycle of water in the Earth's weather, such heating processes can enrich the amount of deuterium. Deuterium/protium analysis in comets found results very similar to the average ratio in the Earth's oceans (156 atoms of deuterium per million hydrogen). This reinforces the theories that much of the Earth's oceanic water is of cometary origin. The deuterium/protium ratio of the 67P/Churyumov-Gerasimenko comet, measured by the Rosetta space probe, is approximately three times higher than that of the earth. This figure is the largest one measured in a comet (at least until now). Deuterium/protium continue to be an active subject of research in astronomy and climatology.

As a first observation, it should be noted that of all hydrogen isotopes known today (over seven), only the first three, protium, deuterium and tritium are found in

nature due to the fact that they have some stability, the others being observed by their production in some nuclear reactions and, in general, having a very low lifespan. That is why we can talk today about the first three isotopes of hydrogen. However, if the first, Protium is extremely stable, the second deuterium is also stable (but less than counter), the third tritium is more unstable. For a long time, it has been considered a nuclear unstable element. That is why we justify reconsidering the feasible fusion reactions of today on the Earth and indicating tritium by abandoning ten years of deuterium (hard water), possibly Protium, but more difficult than tritium.

However, since today there are encouraging results in the attempt to achieve industrial nuclear fusion on the earth with heavy water, it is good to continue these experiments, which is why the theme of this work is still justified, to study carefully deuterium.

Generally, to determine the particle size and subatomic atomic particles, their static diameters (i.e., when the particles are in the resting position) are calculated by various approximate methods (Halliday and Robert, 1966). These dimensions are approximately nano, pico or slightly smaller.

Current phenomena occur when these particles are in the dynamics of motion and therefore it is necessary to know the real dimensions of the moving particles.

This work proposes this. The necessary parameters for the fusion of two ion-positive ion particles (deuterium nuclei) will be calculated.

Known parameters for nano-static fusion will be replaced with dynamic fusion parameters.

The first time will determine the required speed of the accelerated particles to start the fusion when it is cold when it collides.

Secondly, it will determine the radius of the deuterium nucleus in motion.

Third, the potential energy of the two particles (deuterium nuclei) for fusion will be calculated.

This is the kinetic energy that has to reach a nucleus of rapid deuterium to produce collision fusion (Petrescu *et al.*, 2016a; 2016c; Petrescu and Calautit, 2016a; 2016b; Petrescu, 2012).

In the fusion process, two or more atomic nuclei unite or "merge" to form a single heavier nucleus.

During this process, the raw material is not preserved, as part of the earth's fusion is transformed into energy that is released.

The energy that binds energy is greater than the energy of binding of each nucleus that is melted to produce.

It produces an enormous amount of energy.

Creating the necessary conditions for on-site fusion is very difficult to reach a metric scale, the first hydrogen isotope to be subjected to the natural fusion of stars.

Today we know that not only the second hydrogen isotope (deuterium) produces energy for fusion but also the third (hard) isotope of hydrogen (tritium) can produce energy through nuclear fusion.

For a Deuteron, the nucleus of a Deuterium atom, we know the static radius of a nucleon (proton or neutron, Fig. 2) and their range can be determined when the deuteron moves at a linear velocity v , using the Equation 12.

The radius of the nucleus of deuterium in the rest position has been determined in Fig. 2 according to the following Equation 14 (Petrescu *et al.*, 2016a; 2016c; Petrescu and Calautit, 2016a; 2016b; Petrescu, 2012):

$$\begin{cases} R_D = r_0 \cdot A^{1/3} \\ r_0 = 1,45E - 15[m] \text{ the average radius} \\ \text{of a nucleon fixed} \\ A = \text{ the atomic mass} \end{cases} \quad (14)$$

With the Equation 1 (or 12) can be determined with an ultra-high precision the radius of the Deuteron (the nucleus of one Deuterium atom), or any other particles in motion, depending on the speed of its linear movement, v .

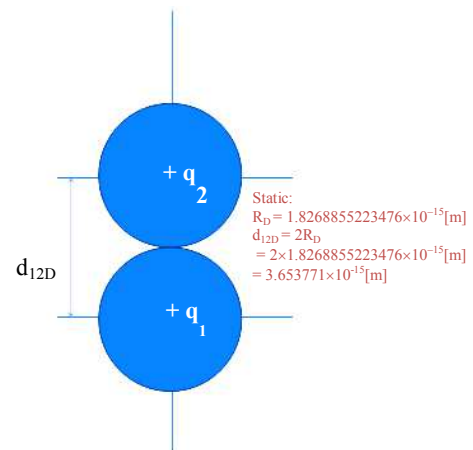


Fig. 2: Two adjacent particles of core of Deuterium

Table 2: The Deuteron radius in function of β

β	0.000009	0.00002	0.0001
R[m]	1.35E-14	1.11E-14	2.22E-15
β	0,001	0,01	0,1
R[m]	8.32E-16	8.32E-14	8.30E-13
β	0,2	0,3	0,4
R[m]	1.65E-12	2.44E-12	3.18E-12
β	0,5	0,6	0,7
R[m]	3.86E-12	4.44E-12	4.85E-12
β	0,8	0,9	0,99
R[m]	4.99E-12	4.54E-13	2.04E-12
β	0,999	0,9999	0,99999
R[m]	7.11E-13	2.32E-13	7.41E-14
β	0,999999	0,9999999	0,99999999
R[m]	2.35E-14	7.44E-15	2.35E-15

Table 2 shows the dimensions of the radius of a nucleon belonging to a Deuteron, depending on the beta ratio, determined with the original Equation 12.

Where beta β , is the ratio between particle velocity and the speed of light in vacuum (Equation 13). You can compare the dynamic values in Table 1 with the static value, $R_D=1,826 \times 10^{-15}$ [m].

The exact dimensions of a deuterium nucleus are very important in the fields of physics, chemistry, material science and so on.

A special application is the one used in nuclear power, with the obvious aim of starting the industrial nuclear fusion reaction. In this case the radius of Deuteron takes the below values (Petrescu *et al.*, 2016a; 2016c; Petrescu and Calautit, 2016a; 2016b; Petrescu, 2012):

$$R_{Ddynamic} = 1.91788E-19 \text{ [m]} \\ \text{(dynamic at } v = 0.002307088c) \\ \text{Static } R_D = 1.827E-15 \text{ [m]}$$

Potential energy has the below values (Petrescu *et al.*, 2016a; 2016c; Petrescu and Calautit, 2016a; 2016b; Petrescu, 2012):

$$\text{Dynamic: } U = E_p = 6.01333E-10 \text{ [J]} \\ = 3753521838 \text{ [eV]} \\ = 3753521.838 \text{ [KeV]} = 3753.521838 \text{ [MeV]} \\ = 3.753521838 \text{ [GeV]} \\ \text{Static: } U = E_p = 6.31284E-14 \text{ [J]} = 3,94E5 \text{ [eV]} = 394 \text{ [KeV]}$$

As you can see the difference between the static and dynamic calculations presented is very high. To achieve cold fusion, we need to accelerate deuterium ions (deuterium nuclei, deuterons) until they reach the required kinetic energy, $E_c = 3.75$ [GeV].

Using static calculations, this potential energy was much lower, $E_c = 394$ [KeV].

In the fusion process, two or more atomic nuclei unite or "merge" to form a single heavier nucleus.

During this process, the raw material is not preserved, as part of the earth's fusion is transformed into energy that is released.

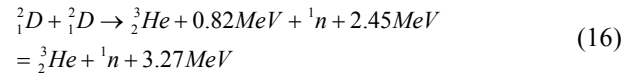
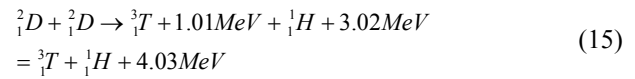
The energy that binds energy is greater than the energy of binding of each nucleus that is melted to produce.

It produces an enormous amount of energy.

Creating the necessary conditions for on-site fusion is very difficult to reach the point where the common hydrogen isotope will be subject to star fusion (antistatic, common isotope, stable hydrogen, other than deuterium and tritium).

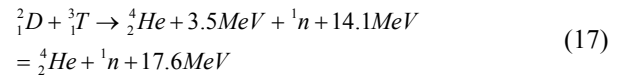
Today we know that not only the second hydrogen isotope (deuterium) produces energy for fusion but also the third (hard) isotope of hydrogen (tritium) can produce energy through nuclear fusion.

The first reaction is possible between two deuterium nuclei, from which one can obtain a tritium nucleus, a proton and an energetic power or a helium isotope with a neutron and an energy Equations 15 and 16:

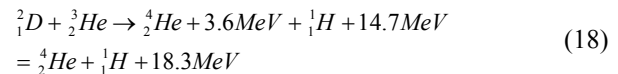


Comments: A core of deuterium has a proton and a neutron; a nucleus of tritium has a proton and two neutrons.

The merger may occur and between a core of deuterium and one of tritium Equation 17:



Another reaction to the merger can be produced between a core of deuterium and an isotope of helium Equation 18:



In the paper (Dumitrescu *et al.*, 2018) it is proposed the theoretical determination of the precision of the dimensions of the elementary particles by the use of very powerful quantum computers. The interesting method also leads to a synthesized theoretical model of the Deuterium (of Deuteron) nucleus formed by a proton and a neutron, two nuclei that came close until they were able to defeat the nuclear repulsive forces and to unite in this way to merge in a single nucleus), (Fig. 3).

The New Model

$$\left\{ \begin{array}{l} J = 2 \cdot \frac{7}{5} m \cdot r^2 = \frac{7}{5} M \cdot r^2 \\ m = \text{the nucleon mass} \\ M = \text{the Deuteron mass} \end{array} \right. \tag{19}$$

It is obvious that two adjacent nucleons will be forced to obtain the position in Fig. 3 and not that of Fig. 2 so that the calculations are refined to achieve greater precision, consistent with the real pattern. Centrifugal care forces act permanently in the particle determines their positioning around the common axis, the axis of the deuteron.

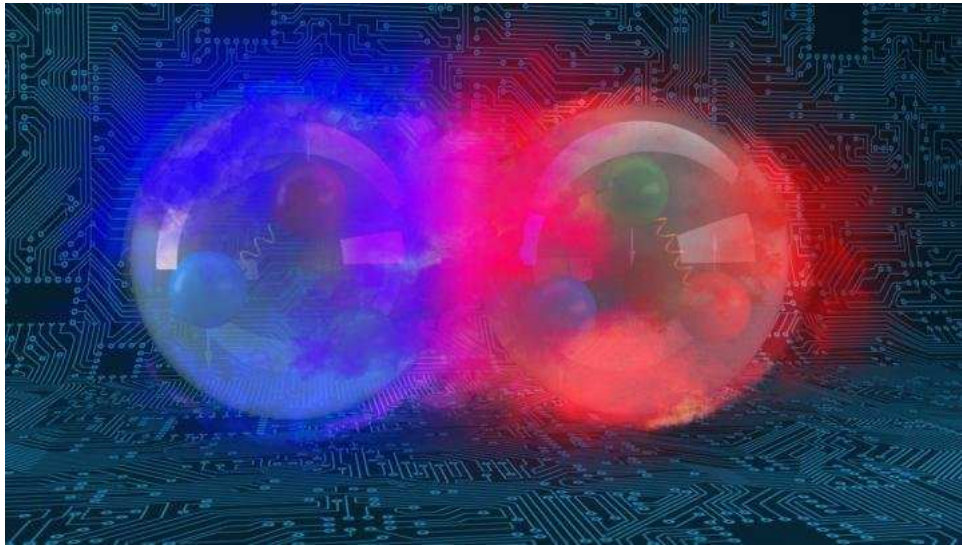


Fig. 3: An image of a deuteron, the bound state of a proton and a neutron. Credit: Andrew Sproles, Oak Ridge National Laboratory -

For this reason, the inertial massic moment measure will be determined according to Fig. 4, relationship 19.

For this reason, the relation 12 acquires the form 20, where M_0 represents the resting mass of the deuteron, v its displacement speed and r is the radius of one of the two components of the deuteron.

$$r = \sqrt{\frac{10}{28}} \cdot \frac{h \cdot \sqrt{c^2 - v^2} \cdot \sqrt{c^2 - \frac{v^2}{2}} - c \cdot \sqrt{c^2 - v^2}}{\pi \cdot M_0 \cdot c^2 \cdot v} \quad (20)$$

The smallest measure of the deuteron will become the diameter of one component, $d=2r$ (21):

$$d = \sqrt{\frac{10}{7}} \cdot \frac{h \cdot \sqrt{c^2 - v^2} \cdot \sqrt{c^2 - \frac{v^2}{2}} - c \cdot \sqrt{c^2 - v^2}}{\pi \cdot M_0 \cdot c^2 \cdot v} \quad (21)$$

A quantum computer uses quantum mechanics to solve specific problems, such as decrypting encryption keys used in secure Internet communication (SSL) over the Internet through the HTTPS protocol.

Deciphering keys used in secure communication is very difficult, ranging from days for 128-bit keys, up to 3 months for 768-bit keys (see Conclusions), using about 100,000 tandem computers, or up to 4,294,967,296 x 1.5 million for 2048 bit keys.

Quantum computers can be used by a special algorithm called Shor, which can reduce decryption times from months or years to just seconds or minutes. The secret is not the speed with which the operations are done, but the fact that those quantum computers need fewer steps than the classical computers to make a calculation.

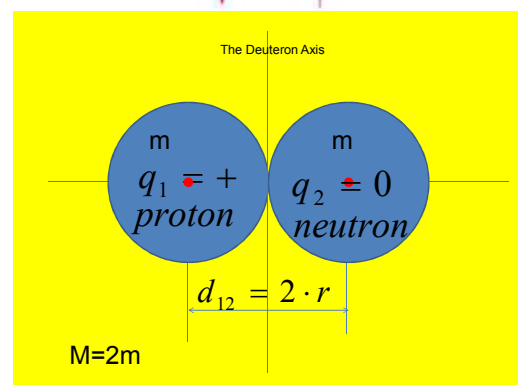
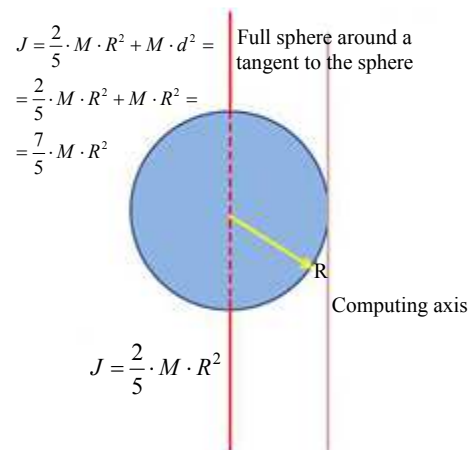


Fig. 4: The nucleons position in deuteron particle

In simple operations, such as watching a movie or listening to a song, a quantum computer would be as fast as today, but success is seen in specific applications, which is why quantum computers are not seen as the rival of classical, but only as complementary machines.

Quantum computers use the fact that qubits can have state 0 and state 1 at the same time (i.e., a superposition), while a classical bit can either have a value of 0 or a value of 1. Since superpositions cannot be measured, a series of logical operations leading to a measurable result.

Superposition is due to the phenomenon called quantum entanglement, a phenomenon that creates a bond between several particles by contacting them. Once that bond has been created, the change in the state of one of the particles will change the state of the other particle even if the second particle has been moved to an infinite distance. The change will be instantaneous regardless of the distance to which the second particle is. Quantum mechanics is weird.

If we want to find out which of the numbers 00, 01, 10, 11 is in the computer, then a classic computer uses two bits to give the result. The two bits offer two numbers, 0 and 1, but two qubits will contain 4 numbers. The amount of information contained in qubit will be equal to 2^n bits.

In other words, in simpler terms, how can electrons or nuclei of atoms be manipulated to use them as qubits. Qubits are the basic units of information stored in a quantum computer. Generally, electrons or nuclei of atoms will be used as qubits. In one of the recent experiments made in Australia inside a classical transistor, a phosphorus atom is inserted and the electron on the upper layer was used as a qubit.

One of the properties of electrons or atomic nuclei is the magnetic spin, an intrinsic property of them, very similar to the electric charge of an electron, for example. Well, that magnetic spin has two states, "up" and "down", which can be manipulated by using radiation.

It is the application of precise frequency radiation to change the spin of the electron or nucleus. Once changed, that spin stays in the same position for a long time (it is assumed to be an infinite number of years, so it can be used as a memory device).

Installations that bring the temperature of the atoms very close to absolute zero are used, after which the electron is placed in a very strong magnetic field and then used by microwaves at the frequency of 45.02 GHz to change its spin. The spin of a nucleus can be changed using microwaves at 44.9 GHz.

No, not like the microwaves in our home, which operates at 2.5 GHz, so we have some qubits go if we heat food in the microwave.

It must be taken into account that the microwave frequency required to change the spin of an electron depends on the magnetic field in which that electron is located.

Much has been talked about quantum computers. Today they are working on difficult simulations, so we can already congratulate the college of researchers at the Oak Ridge National Laboratory as the world's first to successfully simulate an atomic nucleus using a quantum computer. The results that were published in the physical

examination letters demonstrate the huge capacity of quantum systems to calculate the problems of nuclear physics and to be able to be successfully used in the future for special and complex simulations.

It is already known that quantum calculus, which is based on the quantum principles of matter and which was proposed by American physicist Richard Feynman in the early 1980s, unlike the ordinary bits of normal computers today, uses the qubit units used by quantum computers to store information in two-state systems, such as electrons or photons, considered simultaneously in all possible quantum states (essentially a phenomenon known as overlapping).

If classical bits are used in bits of zero and one, Thomas Papenbrock, a theoretical physicist at the University of Tennessee and ORNL, who coordinated the project with the ORNL quantum intelligence expert Pavel Lougovski, informed us in the quantum calculations that use a qubit can have zero, one and any possible combination of zero and one, so as to obtain a much more complex set of data storage capabilities.

In October 2017, a multidisciplinary ORNL team began working on codes to perform various simulations on quantum computers such as IBM QX5 and Righetti 19Q within a DOE Quantum Testbed Pathfinder project in an effort to verify and validate various scientific applications on different types of quantum hardware. The free pyQuil software, which is a specific electronic library designed to produce and manage different quantum training programs, has been used. In this way, the researchers could write a special code that was first sent to a simulator and then to the cloud-based IBM QX5 and Righetti 19Q systems.

The essential part of the experiment was to perform several measurements (about 700,000 quantum measurements) of deuterium, proton nucleus (deuteron) and especially of neutron energy. On this occasion, based on the measurements made, the team could extract the energy of binding the deuteron, the minimum amount of energy needed to disassemble in these subatomic particles. In this experiment, Deuteron is the simplest nucleus of the nuclear compound, becoming an ideal candidate for the project.

"Qubits being some generic versions of quantum systems with two states basically do not possess neutron or proton properties," Lougovski told us. "So we can first map these properties to qubits so that they can then be used to simulate specific phenomena - such as in this case, the mandatory energy."

A great challenge when working with such quantum systems is that researchers first have to run various simulations at a distance and then wait for the results and the working time is higher. Alex McCaskey and the quantum researcher Eugene Dumitrescu have made some individual measurements of 8,000 times each, in order to ensure the statistical accuracy of the obtained results.

"It's difficult to do that on the net," McCaskey said. "This algorithm was mainly built by hardware vendors themselves because only they can actually access the computing machine."

The team also found that quantum devices are difficult to use due to chip noise, which can drastically alter the results of the scientific experiment, which is why it has been necessary to repeat it so many times. McCaskey and Dumitrescu have been able to create strategies to reduce high error rates, such as artificially adding more simulations just in order to see the impact and to infer what could be the result of zero noise, precisely because

"These systems are truly susceptible to noise," said Gustav Jansen, a scientist at OLCF's Scientific Computing Group, a DOE office at the ORNL Science Office. "When particles enter the quantum calculus, they can really change the measurements, so these systems are not perfect, but during their work, we try to better understand the intrinsic errors."

With the completion of this quantum project, it was checked whether the results obtained were in the classical beach of classical measurement methods and it was found that the results of the qubite team were in a range of 2 and 3% compared to the correct answer given by a classical computer, so that this quantum calculation has become the first of its kind in the nuclear physical community.

The importance of these first simulations is great, opening up new research paths, new possibilities for scientific experimentation to calculate heavier nuclei that have more protons and neutrons with quantum systems in the future.

Conclusion

Today, quantum computers have potential applications in cryptography, artificial intelligence and weather forecasting, as each additional qubit clings in some way inextricably from the others, thus exponentially increasing the number of possible results for the final measured state. Obviously, this huge benefit also has negative effects on the system, because errors can in turn exponentially increase the size of the problem and the final results even.

However, it is hoped that in the future on the basis of much-improved hardware, researchers will be able to solve problems that cannot be solved today using current calculation methods (Dumitrescu *et al.*, 2018).

In the present paper the authors propose an original method of rapid theoretical determination with great precision of the dimensions of all elementary particles, the method which, although predicting results similar to those obtained by other theoreticians, still has the advantage of its simplicity, of its general applicability, that is of its universality and especially this new method is a precious tool in the work of scientists worldwide to understand matter at its elementary level.

Even though we would have expected that the size of a deuteron would be larger (double) than that of one component particle (of a proton or neutron), at the same velocity, the theory (20-21) demonstrates the opposite. By fusing two free nucleons, a proton and a neutron, a deuterium nucleus is obtained with smaller dimensions than its two components, which makes the energy of rejection between two Deuteron cores much larger than we would have waited. That's why the fusion reaction between two Deuterons is even more difficult than was suspected, even when they are accelerating.

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Author's Contributions

All the authors contributed equally to prepare, develop and carry out this manuscript.

Ethics

This article is original and contains unpublished material. Authors declare that are not ethical issues and no conflict of interest that may arise after the publication of this manuscript.

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Source of Figures

Fig. 3: Source:

https://www.sciencedaily.com/images/2018/05/180523133216_1_900x600.jpg

Nomenclature

ϵ_0 => the permissive constant (the permittivity):

$\epsilon_0 = 8.85418 \text{ E-}12 \text{ [C}^2/\text{Nm}^2\text{]}$

h => the Planck constant:

$h = 6.626 \text{ E-}34 \text{ [Js]}$

q => electrical elementary load:

$q_e = -1.6021 \text{ E-}19 \text{ [C]}$

$q_p = 1.6021 \text{ E-}19 \text{ [C]}$

c = the light speed in vacuum:

$c = 2.997925 \text{ [m/s]}$

m_0 [kg] => the rest mass of one particle

$m_{0\text{electron}} = 9.11\text{E-}31 \text{ [kg]}$

$m_{0\text{proton}} = 1,672621898\text{E-}27 \text{ [kg]}$

$m_{0\text{neutron}} = 1,674927471\text{E-}27 \text{ [kg]}$

$M_{0\text{Deuteron}} = 3,343583719\text{E-}27 \text{ [kg]}$