American Journal of Engineering and Applied Sciences

Original Research Paper

Interaction between an Electron and a Quark Down

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Article history
Received: 26-07-2020
Revised: 13-08-2020
Accepted: 27-08-2020

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Abstract: The paper briefly studies the interaction between an electron and a down quark, considered integrated within a proton. It is therefore assumed that there is a down quark within a proton in which there are also two quarks up and an accelerated electron capable of penetrating the down quark inside the proton, in extremely difficult conditions in which the proton is already accelerated to a certain level necessary to start the nuclear fusion reaction between two hydrogen protons, in which case a proton already has high kinetic energy, moving at a very high linear velocity and having an extremely small size. Under these conditions, the possibility is studied for an electron to penetrate the proton, or more precisely to be able to interact (to be able to join) the down quark. It determines the kinetic energy required for the electron to achieve a goal like this.

Keywords: Proton, Electron, A Down Quark, Two up Quarks, Nuclear Fusion, Hydrogen Proton, Kinetic Energy

Introduction

In order to discuss in more detail the fusion of two hydrogen protons, it could be interesting to study more widely the quarks inside the proton and other elementary particles with which they can interact.

Whether we like it or not, whether we accept it or not, humanity is heading for a crucial moment.

Global warming as a result of human activity is becoming increasingly evident and globally it does not take much to trigger potentially devastating phenomena that could not be stopped.

Surprisingly, perhaps, recent studies have shown that the contribution of greenhouse gas emissions from human activity is likely to exceed 100% of the total warming effect because in recent years the planet has activated its cooling and air conditioning systems. global temperature. Of the greenhouse gas emissions, about 65% is due to the use of fossil fuels.

In this context, finding non-polluting energy sources and energy generation methods can be crucial in avoiding a major environmental catastrophe. Nuclear energy has always been an attractive way to generate energy, due to its high energy density (millions of times higher than in the case of fossil fuels) and the lack of greenhouse gas emissions.

Nuclear energy can be exploited through two types of reactions: Fission and fusion. Fission consists of "breaking" the nucleus of a heavy atom (usually uranium, plutonium and thorium) into lower mass elements, by bombarding it with neutrons. Fusion is the opposite process of joining the nuclei of two light atoms (usual isotopes of hydrogen or helium).

Nuclear fusion is the process by which two atomic nuclei react to form a new nucleus, heavier (with higher mass) than the original nuclei. As a result of fusion, other subatomic particles are produced, such as neutrons or alpha particles (helium nuclei) or beta particles (electrons or positrons).

Because the merging nuclei are electrically charged, the nuclear fusion reaction can only occur when the two nuclei have sufficient kinetic energy to overcome the electric potential (electric repulsive forces) and therefore come close enough for the nuclear forces (which have a limited range) to be able to rearrange the nucleons. This condition involves extremely high temperatures if the reaction takes place in plasma or the acceleration of the nuclei in particle accelerators.

Nuclear fusion is the main source of energy in active stars.

Nuclear fusion can be classified according to the conditions of thermonuclear fusion and cold fusion. The latter has a controversial status. Investigating cold fusion is an active field. Electrochemical systems with palladium electrodes and heavy water to trigger the deuteron fusion are investigated in this regard.

Thermonuclear fusion could become a virtually unlimited (and environmentally friendly) source of energy when fusion reactors (which are currently in the experimental phase and do not yet produce a net

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surplus of energy) become technologically and economically viable.

Both types of reactions are exothermic (generate heat) and the heat generated can be used to heat a liquid (usually water) that drives a turbine and thus generates electricity.

Fission has been used for over 60 years to generate electricity, but although it is much cleaner than generating electricity using fossil fuels, it has two disadvantages. The first is that the waste resulting from the reactions is highly radioactive (emits extremely harmful radiation) and remains radioactive for long periods of time (thousands of years) and their storage is a complicated problem. The second disadvantage is that, by the nature of the reactions, nuclear fission is a self-sustaining process, which is a risk in the case of out-of-control reactions. In short, fission produces neutrons that in turn hit other atoms and continue to produce fissions. In nuclear reactors, this chain reaction is controlled by introducing control rods into the reactor, which absorb some of the neutrons emitted by fission. In the case of malfunctions in the control system, there is the possibility of serious accidents, with the release of radioactive clouds, as was the case of the Chernobyl accident, the worst in history.

The merger, on the other hand, does not have these problems. The reaction generates very few radioactive materials, with a short half-life (the duration in which radiation emissions are reduced by half) and in case of malfunctions, the conditions for the reactions to take place to disappear, so the reaction stops on its own.

And what conditions! Fusion is the source of energy for stars, whose gravity is strong enough to make reactions possible. In the absence of the enormous gravitational force of a star, fusion can only take place at extreme temperatures: Hundreds of millions of degrees in an isolated environment. At these temperatures, the matter passes into a special form of aggregation, called plasma.

At the moment, the research focuses mainly on two constructive solutions: Inertial fusion and magnetic field fusion. Inertial fusion involves the uniform bombardment of a small amount of fuel (a few millimeters in diameter) with high power lasers, the sudden and uniform heating leading to the implosion of the fuel sphere and the release of energy.

Magnetic field fusion involves heating a larger amount of fuel and maintaining the plasma thus obtained in an isolated perimeter. Unlike inertial fusion, which takes place in pulses, the fusion in the plasma magnetic field must be maintained at temperatures of hundreds of millions of degrees for longer (ideally unlimited).

As there is no material that can withstand these temperatures, the isolated medium can only be obtained by suspending plasma in magnetic fields in a toroidal structure? The magnetic field is obtained with the help of electromagnets (Tokamak and Stellarator reactors). There are other solutions that are being studied, the objectives being the same: Achieving the conditions of pressure and temperature necessary for the fusion of hydrogen isotopes.

Fusion as an energy source presents many challenges for scientists. Currently, the elements used for fusion are deuterium and tritium, isotopes of the hydrogen atom. If deuterium is found in abundance in the oceans, tritium is much rarer and extremely expensive to produce on an industrial scale. Another drawback is that most of the energy released by the fusion of these elements is released in the form of neutrons and neutrons are "immune" to magnetic fields and cannot be controlled. Just like in a fission reactor, neutrons bombard the reactor chamber and cause radiological activation and accelerated damage. In addition, additional measures are needed to protect staff from radiation. Perhaps the most dangerous problem is that the "generous" flow of neutrons can be used, by placing a quantity of uranium 238 inside the reactor, to enrich it in uranium 239. Does it sound known? That's because uranium 239 is used in atomic bombs.

Each type of reactor has, in turn, its advantages and disadvantages, but without going into too much detail, the fundamental problem of fusion is that, so far, due to the inefficiency and shortcomings of current technology, the energy generated by the reactions is less than the energy required to maintain the reaction conditions. In the case of inertial fusion, lasers that bombard the fuel consume a lot of currents and in the case of fusion in the magnetic field, both heating and the formation of the magnetic field are extremely expensive. For the fusion to be feasible, the energy generated must be greater than that consumed. So far, the energy generated covers only 67% of the required energy, at best. From year to year, however, the ratio between the energy generated and the energy consumed becomes more and more favorable.

Fusion is not something that has recently come to the attention of scientists. The first experiments with nuclear fusion were made in the 1930s and the first attempts to control fusion for electricity production began in 1950. Then came the first viable technical solutions, tokamak and stellarator reactors, which would form the basis of the reactors. modern. Although substantial progress is initially made, the technological limitations of the time are holding back the projects. It was not until the second half of the 1960s that promising results reappeared, reaching temperatures closer to those needed for stable fusion. In the 1970s and 1980s, fusion research led to an unprecedented level of international scientific collaboration in the Cold War. During this period, the ITER project was launched, at the proposal of the

Secretary-General of the Soviet Union, Mikhail Gorbachev, to his American counterpart, President Ronald Reagan. The ITER project is the largest international scientific research project in the field of fusion in history, involving Russia, the United States, the European Union, Japan, China, Canada (which has since withdrawn), India, Switzerland and South Korea.

The ITER reactor, Tokamak type, is a demonstration one and will not produce electricity (the thermal energy produced will be released into the atmosphere). The results of the research will be used later in a project called DEMO that could produce about 2GW with the consumption of "only" 80MW. The ITER plant is under construction in France and is expected to be operational in 2025.

Another major project is the so-called Wendelstein 7-X, located in Germany. The Stellarator reactor holds the world record for plasma temperature and pressure conditions and continues to make progress in the plasma holding time in the reactor chamber.

Inertial fusion is implemented in reactors such as Laser Megajoule in France and LFEX in Japan.

At the moment, there are dozens of experimental reactors in operation around the world, both in government-funded projects and in private projects. The entry of the private environment in the "race" to find the optimal constructive solution brings substantial benefits to this process, accelerating innovation.

If we look in the morning at the window we notice that fusion is a real process and the hot summer days clearly indicate that it can generate huge amounts of energy. But can we master the power of the stars?

There is a joke among researchers that describes very well the stage of the merger. It is said that fusion as a form of energy production is always 30 years away. This statement was valid 50 years ago and is still valid today. This field is a very complicated one, with new challenges that appear as we manage to overcome those already encountered. Although the progress of research is visible, the problems that arise repeatedly delay projects and some scientists believe that the merger will never be feasibly mastered and funding should go to other projects.

However, progress is not only made in the field of mergers. New superconducting materials can change the perspective on the feasibility of fusion at any time, computers and artificial intelligence have the potential to revolutionize reactor research (for example, by designing combustion chambers with an improved geometry to eliminate turbulence). At this point, we can still say that fusion energy is still 30 years away, but as fast as certain branches of science progress; surprises can arise at any time. It is important that the solution is found before we completely destroy our habitat.

When fusion is mastered, the planet's energy problems will be solved for a long time in a sustainable and non-polluting way (Halliday and Robert, 1966; Kramer, 2011; Krane and Halliday, 1987; Moses *et al*., 2009; Petrescu, 2019; 2014; 2012a-c; Petrescu and Petrescu, 2019; Shultis and Faw, 2002).

Materials and Methods

As we already said In order to discuss in more detail the fusion of two hydrogen protons, it could be interesting to study more widely the quarks inside the proton and other elementary particles with which they can interact.

Protons (from the Greek πρῶτον = first) are subatomic particles in the nuclei of all atoms, with mass mp = 1,673 · 10−27 kg and positive electric charge qp = e = 1,602 · 10−19 C (Fig. 1). The number of protons is characteristic of all atoms of an element chemical. It represents the number of nuclear charges Z (the number of positive electrical charges). The number of protons determines the position of the element in Mendeleev's periodic system: The number of protons = the number of nuclear charges = the order number. The proton is symbolized by p +.

Because all the protons of an atom have a positive charge and are all in the nucleus, the question arises why they do not repel, a common physical phenomenon in particles with the same sign of electric charge. The answer is given by the quantum field theory: Protons interact not only by electrostatic force but also by strong nuclear forces. The latter is transmitted by gluons.

Protons were discovered in 1919 by physicist Ernest Rutherford.

The problem of defining the radius of a nucleus is similar to the problem of atomic radius, in the sense that neither atoms nor their nucleus has clear delimitations. However, the nucleus can be represented as a positive charge sphere to analyze the results of electron beam scattering experiments. Because the nucleus has no well-defined limits, electrons "see" a series of effective sections that can be considered an average.

A proton (Fig. 1) is composed of three quarks, two up and one down. Each up quark has a positive charge of 2/3e + and the down quark has a negative charge of 1/3e-.

The most logical thing is to position the three quarks of a proton glued together, with no space between them, as we noticed that the whole world of particles is constituted, similar to those in Fig. 2, in which case between the radius of a quark r and that of the proton R appears relation (1):

$$r = \left(2 \cdot \sqrt{3} - 3\right) \cdot R \tag{1}$$

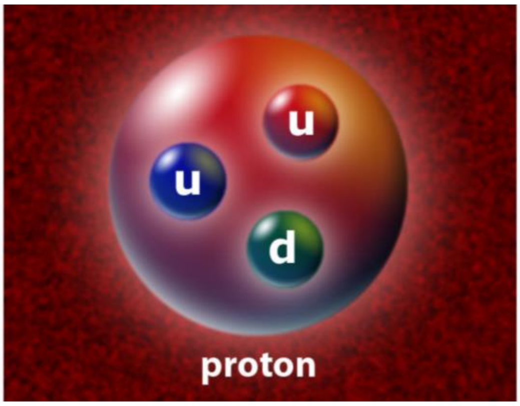

Fig. 1: A proton

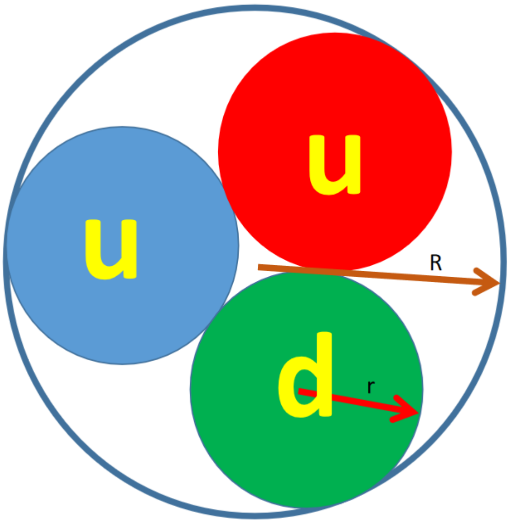

Fig. 2: A proton imagined by the authors

Results and Discussion

The minimum kinetic energy required for an accelerated electron to penetrate the proton to join the down quark (negative as a charge) is calculated by the relation (2):

$$U_{\min}[J] = \frac{1}{4\pi \cdot 8.8541853E-12} \cdot \frac{(-)1.602E-19 \cdot (-)\frac{1}{3}1.602E-19}{2 \cdot \left(2\sqrt{3}-3\right) \cdot R} \quad (2)$$

It results immediately from relation (2) relation (3) which shows the value of the product between the minimum kinetic energy $U_{\min}$ (of electron acceleration, given in J) and the accelerated proton radius R, in m:

$$U_{\min}[J] \cdot R[m] = \frac{1.602^2 E-26}{24\pi \cdot \left(2\sqrt{3}-3\right) \cdot 8.8541853} \quad (3)$$

It is more convenient to express the minimum kinetic energy required in eV, the relation (3) thus acquiring the form (4):

$$U_{\min}[eV] \cdot R[m] = \frac{1.602^2 \cdot 6.242E-8}{24\pi \cdot \left(2\sqrt{3}-3\right) \cdot 8.8541853} \quad (4)$$

The results obtained in the paper (Petrescu, 2020) are now used, regarding the fusion of two adjacent hydrogen protons, where a proton is accelerated to the energy necessary to join, with the corresponding speed and its dynamic radius (very condensed) at the size of 3.84 E-19 [m].

Using for R this value and using the relation (4) just presented, we obtain for the electron, a minimum acceleration energy of: $U_{\min}$[GeV] = 1.3479735 = 1.35.

Such a high value necessary to accelerate an electron so that it can interfere with a proton is very difficult to obtain practically, because electrons at certain received energy tend to lose the energy already stored in the form of photons (by photon emission), being necessary for the correction of this and for the avoidance of the energy loss phenomenon a linear (not circular) acceleration, on a very long distance, difficult to achieve at the reactors known until now.

Conclusion

The fusion processes of matter are difficult to achieve and control today, but they are extremely necessary for humanity.

It is imperative that theoretical and experimental studies be further supported by all possible efforts because the completion of these processes will lead to clean, friendly energy, endlessly, bringing great benefits to mankind in the future, a future that we hope will be as close as possible.

The final resolution of energy crises in the future so that they do not occur will effectively lead to a better life for all people, but also to some important achievements for humanity in the most essential areas of life.

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Acknowledgement

This text was acknowledged and appreciated by Dr. Veturia CHIROIU Honorific member of Technical Sciences Academy of Romania (ASTR) Ph.D. supervisor in Mechanical Engineering.

Funding Information

Research contract: Contract number 36-5-4D/1986 from 24IV1985, beneficiary CNST RO (Romanian National Center for Science and Technology) Improving dynamic mechanisms internal combustion engines.

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Author's Contributions

All authors equally contributed in this work.

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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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]

Source of Figures:

Fig. 1
https://www.universetoday.com/56013/proton-parts/