LETTERS TO PROGRESS IN PHYSICS

Calculating the Parameters of the Tetraneutron

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A large international group of theorists, using the high precision nucleon-nucleon interaction between neutrons, issued the theoretical estimates of the four-neutron (4n) system resonance state energy and its lifetime. For this purpose numerous calculations using supercomputers have been made and obtained the values of 0.84 MeV and 5×10^{-22} seconds. The same results were obtained with much less efforts based on the mechanistic interpretation of John Wheeler's geometrodynamic idea.

1 Introduction

In the Japanese RIKEN Institute as a result of experiments by the decay of 8He nuclei (alpha particle and four neutrons) some events managed to allocate, which are interpreted as short-lived resonance state of the tetraneutron. In a recent article, published in Physical Review Letters [1], according to calculations the tetraneutron resonance energy is estimated at 0.84 MeV, and its lifetime is about 5×10^{-22} seconds, which is consistent with the Japanese experimental data.

According to the first author of the article Andrey Shirokov (MSU: Lomonosov Moscow State University), "*… theoretical approach has been carefully designed and numerous calculations using supercomputers were made…*". For the calculation of only a few parameters characterizing tetraneutron scientific forces of the various institutes and organizations were involved in the work process and the expensive computing resources based on international scientific cooperation were expended. As stated in the original, "*Computational resources were provided by NERSC, which is supported by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231 and by Lawrence Livermore National Laboratory (LLNL) institutional Computing Grand Challenge program under Contract No. DEAC52-07NA27344*".

There is a great regret for the efforts and the lack of other physical paradigms that could have given the same result with much less expenses. The same is confirmed by the authors themselves: "*More recent state-of-the-art theoretical calculations have concluded that without altering fundamental characteristics of the nuclear forces, the tetraneutron should not be bound. More theoretical calculations were performed, all of them agreeing that a bound tetraneutron is not supported by theory*".

2 Calculation of the tetraneutron parameters

The basis for one of the alternative theories could be a model based on the use of the elementary *mechanistic interpretation of J. Wheeler's geometrodynamic concept* where the charges are seen as singular points on the three-dimensional surface, connected "wormholes" or current tubes by drain-source type through an extra dimension, forming in general a closed *contour*. It is assumed the existence of common or similar natural laws, which are reproduced at different scale levels of matter. Earlier, on the basis of this model the binding energy of the deuteron, triton and alpha particle have been determined [2], as well as many other parameters for both micro- and macrocosm [3–6].

We now determine the binding energy for the tetraneutron. Let us recall that the contour or vortex thread having a radius r_e and the linear density m_e/r_e, along which some medium with velocity v circulates, a vortex thread with radius r fills a spiral manner. The vortex thread can be regarded as completely "stretched", i.e. elongated proportional to r_e/r or, on the contrary, extremely "compressed", i.e. shortened proportional to r_e/r and filling all the vortex tube of radius r_e.

In papers [3, 4], proceeding from the conditions of conservation of charge and constancy of the linear density when contour's changing, parameters of the vortex thread v, r for an arbitrary plus-minus contour is defined as a proportion of the light speed and electron radius as:

$$v = \frac{c_0^{1/3}}{(an)^2}\,, \tag{1}$$

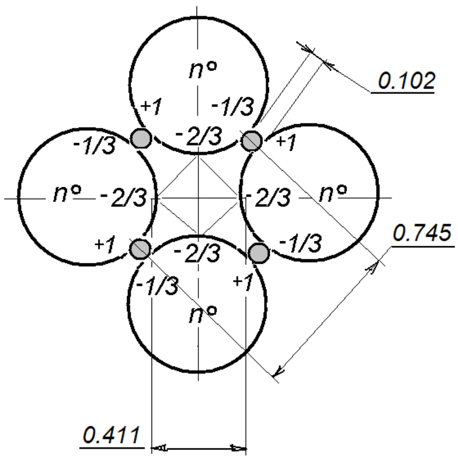
$$r = \frac{c_0^{2/3}}{(an)^4}\,, \tag{2}$$

where n is the own quantum number for the microparticles, a is the inverse fine structure constant, c_0 is the dimensionless velocity of light, c/[m /sec]. For the proton

$$n = \left(\frac{2c_0}{a^5}\right)^{1/4} = 0.3338, \tag{3}$$

and of the above formulas it follows: $v = 0.320$, $r = 0.102$.

Assume that neutrons, surrounding an alpha particle before decay of 8He, is polarized the same as in the alpha-particle (1, −2/3, and 1/3). Let the four polarized neutrons disposed symmetrically like the nucleons in the alpha particle, as shown in the figure. Charge radius neutrons r_n is assumed to be the radius of the proton, plus 3% (since on this



value the radius of the neutron magnetic moment distribution is increased in comparison with that of a proton), then

$$r_n = 0.322 \text{ (or } 9.07) \times 10^{-16} \text{ m.} \tag{4}$$

There are taken into account four interactions between charges of +1 and −1/3 (attraction) at a distance $r = 0.102$, and six interactions between charges of −2/3 (repulsion), i.e. their projections on the sides of the square and along the diagonals at distances determined from geometrical considerations (0.291 and 0.411). The minimum distance between the charges made equal to the transverse dimension of the nucleon vortex tube (thread) $r = 0.102$. This characteristic size has also been adopted by reason that for the magneto-gravitational equilibrium with given parameter and charges of +1 and −1/3 the product of the quark masses, involved in the circulation contour, found to be equal to the value of 84.3. Thus, the average mass of the quarks $(84.3)^{1/2} = 9.18$ is nearly the mass of two neutron quarks ($8.6\, m_e$), defined on the basis of entirely different reasons earlier [4].

The tetraneutron bonds form a closed system, so one can assume that the tetraneutron binding energy is the averaged binding energy of a link, since at destruction of a link the particle splits as a whole (as the alpha particle). Having in mind the accepted scheme of charges arrangement, tetraneutron geometry, and specified dimensions, we can write the final formula for the binding energy as the average energy per bond. For single charges in units of MeV, and in a proportion of r_e we have:

$$E = \frac{0.511}{r}\,. \tag{5}$$

In our case by substituting the data we obtain:

$$E = \frac{0.511}{4} \times \left(\frac{4 \times 1 \times \frac{1}{3}}{0.102} - \frac{4 \times \frac{2}{3} \times \frac{2}{3} \times \cos 45^\circ}{0.291} - \frac{2 \times \frac{2}{3} \times \frac{2}{3}}{0.411} \right) = 0.835. \tag{6}$$

Note, that if the charges of the polarized neutron is (+2/3, −1/3, and 1/3), and in this case the binding energy is approximately the same amount.

Tetraneutron instability can be explained by the fact that kinetic energy of the tetraneutron quarks (having a total mass m_k and rotating on the same radius r at speed υ), is comparable to the binding energy. Let's equate these energies. At the units of MeV we have:

$$m_k\, m_e\, (\upsilon c)^2 = 0.835 \text{ MeV.} \tag{7}$$

Since $m_e c^2 = 0.511$ MeV, then from (7), by substituting the values of υ, we have $m_k = 16.0$. That is, the value, which is close to the total two neutron quark mass involved in the circulation counter, creates the inertia repulsive forces that can destroy, at least, one bond of the tetraneutron.

The lifetime of the tetraneutron τ is determined from the reason of the duration of existence of four neutrons in a bound state, which should at least be sufficient for one circulation of medium flow along the contour having some diameter d. Suppose that it is equal to the distance between the centers of neutrons, $d = 0.745$.

Then, taking into account the "stretching" (i.e. elongation of the vortex thread is a multiple of $1/r$ and decreasing in the flow velocity is a multiple of υ), and substituting the data we obtain:

$$\tau = \frac{\pi\, d\, r_e}{c} \times \frac{1}{\upsilon r} = 6.73 \times 10^{-22} \text{ sec.} \tag{8}$$

3 Conclusion

Thus, the calculated parameters of the tetraneutron are consistent with those obtained in the experiments of RIKEN and coincide to those declared in [1] that once again proves the validity of the proposed model.

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