The Spacetime Importance of the Neutron and Simple, Precise Calculation of the Energy Levels and Lifetimes of the Neutron and Deuteron ${}^{2}_{1}\mathrm{H}$ Using Natural Constants

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Based on the Geometry of Spacetime Structures [1–3], this short paper briefly argues the importance of the neutron in the creation of natural spacetime. It also uses only the most fundamental natural constants to simply and precisely derive and calculate the energy levels and lifetimes of the neutron and deuteron ${}^{2}_{1}\mathrm{H}$.

According to the Geometry of Spacetime Structures, the only non-zero-mass elementary particles in nature are the proton and the electron. Taking the proton, electron (and photon) as the starting point of natural creation, the neutron is the first natural "spacetime structure" possessing a certain stability. That is, in three-dimensional natural space, it is a spatially symmetric material structure with a dimension count D (a compact inertial mass, also energy， and D<3) ,and with spatial scale tending to zero but not equal to zero (r→0 and r≠0). Clearly, the neutron's spacetime structure parameters – including its mass m_n, energy level $\Delta\mathcal{E}$, lifetime τ, structural symmetry degree D, and spatial scale – are all important spacetime "constants". They depend only on the most fundamental natural constants: the proton mass m_p, electron mass m_e, charge quantum e, Planck constant h, vacuum permittivity ε_0 , gravitational constant G, and π, etc. As a neutral mass quantum, the neutron is the "key" to nuclear fusion and nuclear reactions.

The strong interaction is a material interaction with r→0, characterized by mass-energy conversion (±Δm ≠ 0), and with an intensity approaching that of the electromagnetic interaction as r→0. In essence, it is a different kind of electromagnetic interaction that involves matter-energy conversion. One neutron consists of one proton and one high-energy electron moving rapidly around the proton. The neutron energy level is higher than that of the proton by $\Delta\mathcal{E} = (m_n - m_p)c^2 = +1.2933$ Mev $= 2.531 m_e c^2$. The neutron's high energy level $\Delta\mathcal{E}$ and its decay period τ are important spacetime-matter parameters.

When r→0, the integration of space-time and matter occurs, the stability of the neutron – its lifetime τ – due to the neutron's special status, should obviously reflect the most essential natural constants and spacetime laws. Therefore, its stability must be inversely proportional to its high energy level, i.e., $\boldsymbol{\tau} \propto h/(m_n - m_p)c^2$; and because the electron moves at high energy around the proton, τ must be proportional to π□ ∗ (m_p/m_e); furthermore, as a single-particle state, and with secondary corrections from long-range interactions in natural space, τ is clearly proportional to the electromagnetic attraction energy $\sqrt{e^2/4\pi\varepsilon_0 r}$ and inversely proportional to the neutral, longer-range gravitational attraction $\sqrt{Gm_p m_e/r}$. Thus we immediately obtain:

$$\tau = \frac{\pi h}{(m_n - m_p)c^2}\,\frac{m_p}{m_e}\sqrt{\frac{e^2}{4\pi\varepsilon_0 G m_p m_e}} \qquad (1)$$

Equation (1) simply unifies the three fundamental forces of nature in an elegant algebraic expression (weak and electromagnetic are one).

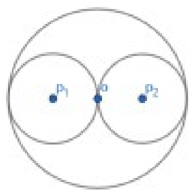
Equation (1) was first discovered by Yixing D.Z. in China. The calculated result is 878.5 seconds. The neutron has a high energy level of $+2.531 m_e c^2$, which destined it to have a short lifetime. The

2021 experimental result is 877.75 seconds. The difference between the two is less than one second. In comparison, the author has more confidence in the result of equation (1), which is expressed entirely in terms of the most fundamental natural constants. Equation (1) also provides a method for calculating the m_p/m_e constant.

According to the geometry of spacetime structures, when $r \to 0$, spacetime, matter, and energy are unified, i.e., $\Delta t \sim \Delta r \sim \Delta m \sim \Delta E$. For the neutron spacetime structure “created” from a proton and an electron, $\Delta r \sim \Delta m \sim \Delta E$, which includes $+2.531 m_e c^2$, is entirely contributed by the electron moving at high speed around the proton. The set of electron spacetime states inside the neutron is equivalent to a compact sphere (full solid angle 4π). Taking one spherical degree as one electron state unit (the solid angle of one electron $\Delta\Omega \sim 1 * \Delta S/\Delta r^2 \sim 1$), the number of electron motion states is exactly the solid angle of the compact sphere, 4π. Therefore, the degree of freedom D of the electron is $D=\ln 4\pi=2.531$. That is, the material energy contributed by the electron inside the neutron is $+2.531 m_e c^2$.

According to the geometry of spacetime structures, there are no independent high- energy neutrons inside an atomic nucleus. The nucleons inside the nucleus are all protons p+. Neighbouring protons strongly attract each other by exchanging high- energy an electron e−, forming a multi- dimensional dynamic fully symmetric structure with the p+e−p+ pair as the basic repeating structural unit. This nuclear spacetime structure, constructed by equivalent protons through zero- range nearest- neighbour strong interactions, is a compact fractal structure with a fractional dimension D.

Calculation of the nucleon binding energy of the deuteron ${}^2_1H$. The structure of ${}^2_1H$ is simply the pep quantum pair state. The pep quantum pair has two equivalent states: p_1ep_2 and p_2ep_1. As shown in the figure, two tightly bound protons can occupy any equivalent state within their circumscribed sphere (compact symmetry in 3D space). The volume of the circumscribed sphere is four times that of the protons themselves. That is, ${}^2_1H$ has four equivalent states, including p_1ep_2 and p_2ep_1. For each equivalent state, one electron is exchanged, contributing a total binding energy level of $-4m_ec^2$. In addition, it should include as many as possible odd numbered angular spin quantum states of the same type of quantum combination (pep) (the sum of even numbered angular spin quantum numbers is 0; each proton may be in angular spin quantum states of several pep units with other protons, with a statistical average contribution). That is, ${}^2_1H$ includes at least possible angular spin quantum states composed of 3 and 5 units, contributing $-2\times(1/3!+1/5!)m_ec^2= -2\times0.175m_ec^2$. Therefore, the total binding energy level of ${}^2_1H$ is approximately $-4.35\, m_ec^2$,so the binding energy per proton is approximately $-2.175 m_ec^2$. The conventional calculated value is about $-2.176 m_ec^2$. The results agree. This also indicates that there indeed exist cluster- like angular spin quantum statistical states for protons inside atomic nuclei.



${}^2_1H$

The binding energy of the deuteron ${}^2_1H$ is negative, its structure is compact and stable, with a very long lifetime.

References

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