New discoveries in protons

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Abstract Protons are composed of three valence quarks. What is the relationship between the three valence quarks? In particle physics, it is difficult to find the mass relationship of three valencequarks in protons because the mass of quarks is not accurate. However, by analyzing the experimental results of seaquest carried out by **Fermilab** in **2021**, it is found that the upper quark and the lower quark have an accurate mass ratio (**$m_u/m_d=0.707$**). The exact ratio of the upper quark mass to the lower quark mass (**$m_u/m_d=0.707$**) is another way to study the quark mass in protons. The discussion on Higgs mechanism and vacuum condensation of **QCD** can be avoided. The uncertainty of quark mass is transformed into the exact ratio of quarks in the same system to study.

By analyzing the exact ratio of the mass of upper quark to lower quark in proton (**$m_u/m_d=0.707$**), it is found that there is a relation of **$m_u^2+m_u^2=m_d^2$** in proton. The sum of squares of up quark mass in protons is equal to the square of down quark mass. The basic content of quark law in baryons: except protons, all heavy quarks in other baryons will decay into up quark or down quark, and the sum of squares of up quark mass should be equal to the square of down quark mass. According to **$m_u^2+m_u^2=m_d^2$**, it is deduced that there are three generations of protons in the universe. That explains why protons are stable. And analyze the reasons for the expansion of the universe.

Key words valence quark quark law three generation proton exact ratio

I Introduction

The theory of **Standard Model** and **QCD** have been born for decades, which have successfully explained many problems in particle physics. However, the value of quark mass given in **Standard Model** is uncertain. Because quarks are confined in hadrons, there are no free quarks in nature. Therefore, the mass of free quarks cannot be obtained directly from experiments. Based on the experimental results of **seaquest** in **Fermilab** in **2021**, this paper explores the relationship between three valence quark in protons. The exact mass ratio of the upper quark to the lower quark **(m_u/m_d=0.707)** was successfully found. Could explain the proton stability? At the same time, a new viewpoint is put forward for the existence form of protons in stars.

II Experimental methods

In **2021**, Fermilab carried out seaquest's experiment, and each anti-upper quark corresponds to **1.4** anti-lower quarks **[1]**.

III Derivation of the mass relationship between up quark and down quark in proton

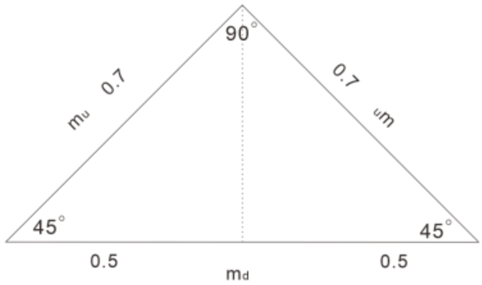
There are three valencequarks in the proton and a large number of seaquarks. According to experimental facts, protons are the most stable particles. The stability of protons must be governed by some condition. What is this condition?
According to the experimental results of sea quark, each anti-upper quark and anti-lower quark in proton is not equal in charge and mass. At the same time, the number of anti-upper quarks and anti-lower quarks is not equal.

Suppose that the product of the charge,mass and number of the antiquark is equal to the product of the charge,mass and number of the antiquark.
Because quarks and antiquarks are equal in mass, opposite in charge and opposite in color and flavor. Therefore, the anti-upper quarks and anti-lower quarks in **seaquest**'s experimental results can be treated as upper quarks and lower quarks.
Because the products of the three are equal (the charge is positive). The following relationship is obtained.

$$\frac{2}{3} \times 1.0 \times m_u = \frac{1}{3} \times 1.4 \times m_d$$

$$m_u/m_d = 0.7$$

There are two upquarks in the proton. Assuming that the mass of down quark is **1** and the mass of up quark is **0.7**, a mass triangle is established.



Figure(1) Triangular diagram of upper quark and lower quark

Cos a = $\frac{0.5}{0.7}$ = 0.7142 **cos45° = 0.7071**

Considering the error of experimental data, it can be considered that **a=45 °.**

Therefore, the figure is an isosceles right triangle. Two up quark are right angles and down quark are hypotenuses.

So we get the following conclusion: $m_u^2 + m_u^2 = m_d^2$

Described in physical terms as: the sum of squares of up quark mass is equal to the square of down quark mass.
According to the existing experimental data, the mass of the upper quark is **(1.7~3.3)MeV**, and the mass of the lower quark is **(4.1~5.8)MeV**. The above conclusion is also within a reasonable range.

IV Results

(1) The exact mass ratio of upper quark to lower quark can be obtained by Seaquest experiment. $m_u/m_d = 0.707$

In the original experiment, **1** antiquark corresponds to **1.4** antiquarks. Considering the experimental error, the most accurate experimental result is: **1** anti-upper quark corresponds to **1.414** anti-lower quarks, so $m_u/m_d = 0.707$.

(2) The sum of squares of up quark mass in proton is equal to the square of down quark mass. $m_u^2 + m_u^2 = m_d^2$

V Discussion

(a) The popularization of $m_u^2 + m_u^2 = m_d^2$

(1) Multiply both sides of $m_u^2 + m_u^2 = m_d^2$ by (a^2) at the same time, and the relationship becomes $a^2 m_u^2 + a^2 m_u^2 = a^2 m_d^2$

From the above relationship, we can draw the following conclusion: the mass of valence quarks changes by a factor at the same time, and the equation still holds. Considering the quantum characteristics of quarks, **(a=1, 2 , 3).** **a** should not be too large, otherwise the valence quarks will be unstable. In addition, if the value of **a** is too large, the lower quark will approach the second generation quark.

So there are three generations of protons in the universe. Charge,color,flavor are the same among all generations of protons. The difference is mainly that the valence quarks have different masses and their environments are different. Three isotopes **(H,D,T)** similar to hydrogen in chemistry. The specific charge of **3** valence quarks is **1:2:3**.

Ordinary protons are the third generation protons, and valence quarks are the lightest. The center of the star is the first generation of protons, and the valence quark is the heaviest, which is **3** times that of ordinary protons. The inner layer of the star's surface is the second generation proton, and the valence quark is **2** times that of ordinary protons. Some cosmic rays also contain a small amount of second generation protons.

(2) The valence quarks in the third generation protons change synchronously, which is obviously different from the existing baryon decay mode.

(3) When **a=3**, it is the first generation proton. When a nuclear fusion reaction occurs in the center of a star, the first generation of protons must first decay into ordinary protons, and a lot of energy needs to be released in the process. In addition, the second generation protons also lose energy when they become ordinary protons. The second generation protons decay into ordinary protons, and the lost energy provides power for the expansion of the universe.

(4) When **a=2**, it is the second generation proton, which is mainly located in the inner surface of the star. Take the sun as an example. When the second generation protons decay into ordinary protons, they will release energy. These energies not only provide the expansion power of the universe, but also heat the corona layer. The phenomenon of high temperature in the corona of the sun.

(b) Analysis of proton stability and quark law in baryon

Because the three valence quarks in the proton satisfy ($m_u^2 + m_u^2 = m_d^2$), but there

is no such relationship in other baryons, the proton is the most stable.
According to the experimental facts, the quark law in baryons is summarized.

[Quark law in baryons]: except protons, heavy quarks in other baryons will decay into up quark or down quark. And keep the sum of squares of the up quark mass equal to the square of the down quark mass.

(c) This paper is based on the discussion (**C×M×N**) that the product of the upper quark and the lower quark in proton is equal in mass, number and charge. According to the first principle, it can solve many problems in particle physics and astronomy. Therefore, this assumption is reasonable.

(d) In particle physics, the quality of quarks mainly comes from two aspects: **Higgs mechanism[2]** and vacuum condensation of **QCD[3]**, both of which have complex operations. The **seaquest** experiment in **Fermilab** provides a new idea for exploring the quality of quarks.
The contribution of **seaquest** experiment in **Fermilab** to the study of quark mass is**:** on the premise that the exact mass of upper quark and lower quark cannot be obtained, the **exact ratio** of the mass of upper quark and lower quark is given. This experiment transforms the uncertainty of quark mass into the exact ratio of upper quark mass to lower quark mass. Therefore, it is of great significance to study the mass ratio between valence quarks in the same system. Just as the exact ratio of the mass of upper quark to lower quark in proton (**m_u/m_d=0.707**), it provides an experimental basis for the discovery of (**$m_u^2 + m_u^2 = m_d^2$**).

(e) Seaquest experiment in **Fermilab** looks for the ratio of anti-upper quark and anti-lower quark in proton on the surface, but the exact ratio of the mass of upper quark and lower quark has a greater influence on particle physics.
The uncertainty of quark mass comes from **(1)** not being directly observed. **(2)** The strong interaction is not very clear. (3) The theoretical model has limitations.
Although the quality of quarks is uncertain, by adjusting the research ideas, we can also find the relationship existing in protons: **$m_u^2 + m_u^2 = m_d^2$**

VI Summary

The uncertainty of quark mass is a core problem in particle physics that has not been completely solved for a long time. Finding the exact ratio of the upper quark mass to the lower quark mass in protons (**m_u/m_d=0.707)** can avoid the discussion of **Higgs mechanism** and quark vacuum condensation, and provide an experimental basis for the discovery of **$m_u^2 + m_u^2 = m_d^2$**. The main composition of the universe is

hydrogen. Discovering the relationship between three valence quarks in protons can not only promote the development of particle physics, but also promote the development of astronomy. Is there 3 generations of hydrogen in the star? It needs physicists and astronomers to face it together. (**$mu^2 + mu^2 = md^2$**)in protons is a major discovery in particle physics. Although the exact mass of quarks cannot be obtained at present, the acquisition of the exact ratio **($mu/md=0.707$)** is also a major progress in particle physics. How to study the quality of quarks? In the same system, quarks exist in the same environment, so it is meaningful to find the exact ratio between quarks.

VII References

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