Phase changes and interactions of energy and matter in the universe viewed through temperature change

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ABSTRACT

The universe is indeed composed of energy and matter. Matter can be measured by weight. Energy can be measured in terms of temperature. The higher the density, the higher the temperature, and the lower the density, the lower the temperature. If our universe started from a small point with a very high temperature and reached today, as the universe expands, the density of energy decreases, so the temperature lowers, too. When the temperature lowers, some of the energy causes a phase change into matter, and vice versa. When matter is created, an interaction takes place. At 10^{13} K, imps (invisible material particles, aka dark matter) are created and a gravitational field is formed as a result of emitting graviton acting on it, which gains masses.

Down quarks and up quarks interact with their own intrinsic properties. This interaction is called the quark interaction. When two down quarks and one up quark meet with an imp to create a neutron, the force resulting from the quark interaction is confined inside the neutron. The quark interaction confines the strong force when quarks form a neutron, and mediates the electromagnetic field and electromagnetic force when a neutron transforms to a proton, and binds the nucleons to form heavier particles by strong nuclear interaction.

Keywords: Energy; High temperature; Mass; Interaction; Particles

INTRODUCTION

Pure energy era (Temperature: 0 K ~ 10^{32} K)

Energy is present not only in our surroundings but also everywhere in the universe. Energy cannot be created or destroyed, and it propagates through light. Light has energy. It is the temperature that measures the size of energy. The temperature of pure energy is given by

$$I= E/k_B \qquad (1)$$

Where; T is the temperature in Kelvin, E is the unit amount of energy, and k_B is the Boltzmann constant.

Applying the Planck mass $M=M_P$, one can obtain the Planck temperature $T=T_P$.

Energy flows from areas of higher density to areas of lower density. When a system with higher energy meets a system with lower energy, the energy flows by the process of radiation, convection and conduction, and when the temperatures of the two systems become equal, the energy flow stops. Unless these systems expand or contract, the state of the two systems will continue to remain the same [1-3].

Energy is not compressed by itself. When energy is compressed by external pressure such as gravity, the density increases, so does the temperature.

Whether a force that compresses energy and confines it in a small space is due to internal contraction in addition to external pressure, or the energy trapped in such a space is a result of some other force (repulsion) or a trigger (beginning of time), remains unknown. If the energy has the repulsive force, we call this repulsive force dark energy and assume that it is the cause of the expansion of the universe [4,5]. The pure energy appears to have started at Planck's temperature and reached the currently observed temperature. The universe will continue to expand until the temperature of the energy reaches the absolute zero or if some unknown force or forces will stop the expansion and even go down the path of contraction.

As the Big Bang expands space time, it expands at the speed of light, increasing its volume. As the volume increases, the energy density decreases and so the temperature lowers accordingly.

Since the total energy in the universe is invariant with changes in volume and temperature, Planck's law can be applied to the universe, as follows:

$$U=\omega T^4 V \qquad (2)$$

Where U is the total energy of the universe, $\omega=7.56573 \times 10^{-16}\ Jm^{-3}K^{-4}$ is the radiation density constant, V is the volume of the universe and T is the temperature at the time of observation of the universe [6-8]. And according to the Einstein field equations [7], the total energy in the energy dominated space time 3 is

$$U = 3Mc^2 \qquad (3)$$

Where U is the total energy from the equation (2) and M is the total rest mass of the universe.

LITERATURE REVIEW

Quark era (Temperature: 10^{10} K~10^{13} K)

300 seconds after the Big Bang, as the universe expands, the temperature reaches 10^{13} K, leading to the decay of top quarks and Higgs particles into bottom quarks and Higgs bosons, respectively. The top quark releases the majority of its own energy, up to 97.6%, during this process. As the temperature decreases, the bottom quark transforms into a charm quark, the charm quark into a strange quark, the strange quark into a down quark, and finally the down quark into an up quark [13]. According to the energy-mass equivalence principle, 10^{13} K is also the temperature at which mass is converted into energy. So when the temperature reaches this point, energy is converted into matter with mass. As the temperature increases, mass is converted into energy, and when it decreases, some energy is converted back into mass.

As the temperature decreases, at 10^{13} K, some of the energy generates invisible matter particles (imps, also known as dark matter). Imp releases gravity and the gravitational field, so it has mass. Imp is not the matter that can be observed with the naked eye, but it is known to exist under the influence of gravity [14]. According to the principle of energy-mass equivalence, the temperature at which matter converts to energy is 10^{13} K, so when energy is condensed and reaches 10^{13} K, it can be said that matter

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has been created. And because that matter is unobservable, what is known as dark matter, now called imp. At 10^{10} K, the imp undergoes baryon synthesis, encounters two down quarks and one up quark, and is converted into a neutron.

In quark era, it is the time when energy particles represented by quarks and material particles represented by imps coexist.

Imp (aka dark matter)

An imp has at least a mass of 927.7 MeV/c^2, a neutron has a mass of 939.6 MeV/c^2, and a proton has a mass of 938.3 MeV/c^2. Neutrons have more energy than imps because they wear clothes called down quarks and up quarks, although they are made at lower temperatures at 10^{10} K.

When an imp clothed, it is converted into a neutron that becomes visible matter. This means that the clothed imp would become an opaque neutron due to the quarks. It is known to occupy only 5% of the universe in observable matters [15]. This shows that imps account for 32% of the total energy, while matters (imps in clothes) account for 15.5% only of the total imps. The rest are still naked imps.

Of the total quantity of down quarks, exactly one-third are converted to up quarks. As soon as a down quark transforms into an up quark, the up quark fuses with two down quarks to form a neutron, so when the down quarks are exhausted, no more quark bonds happen eventually.

Quark interaction

At 10^{10} K, the temperature at which up quarks are created, the first particle-to-particle fusion takes place, producing neutrons. Since neutrons are converted to energy at 10^{13} K, the temperature at which energy is converted to neutrons must also be 10^{13} K, but in reality neutrons are produced at much lower temperatures at 10^{10} K. When a down quark transforms into an up quark, the up quark immediately combines with two down quarks and an imp to create a neutron. So far it is known to be involved in this process is a gauge boson called the gluon [16]. Gluons are called vector gauge bosons that transmit strong nuclear forces.

However if we take a closer look at this process: Down quark and up quark have three virtual hands called chiros on three sides of the trisected sphere of their own, which are compared to the three kinds of charges in Quantum Chromodynamics (QCD). The three d-chiros of the down quarks are intrinsic properties of the down quarks, and the three u-chiros of the up quarks are also intrinsic properties of the up quarks. These chiros are unique properties that are used to interact with both down quarks and up quarks. To make one neutron, u-chiros and d-chiros of quarks combine in clockwise order in the form of "du-ud-dd" with an imp in the center. The bonds are trapped inside the neutron. This quark bonding is called quark interaction, and the confinement force is the strong force or residual force. Thus, the sum of the attractive forces "du-ud-dd" between the three chiros confined by the quark interaction is the strong force in the neutron.

DISCUSSION

Strong interaction

Strong interaction is a force that appears as a result of quark interaction. It is a very strong force, but it is confined to the inside of neutrons and does not appear on the outside. Neutrons are bound to quarks by strong forces, but strong forces do not interact with other material particles. Interactions with other particles are not caused by the strong force, but by the bond of the exposed chiros, and the quark bond only confines the strong force within the nucleon.

Since the temperature at which neutrons have been created is very high at 10^{10} K, so they are in active motion, and as the density of neutrons increases, the number of collisions with each other increases, too. But nuclear fusion between neutrons does not occur to form a dineutron. The reason for this is that there is a possibility that the collision between neutrons is a perfectly elastic collision [17]. Or the two d-chiros of dineutron generated by quark bonds are relatively less stable compared to the "ud" chiros of a deuteron. However, when the ambient temperature is lowered to 10^7~10^8 K, the dineutron may become a stable deuteron.

When a neutron releases an electron and becomes a proton, the quark bond becomes a combination of "du-uu-ud". There is a difference in strength between the strong force in neutrons and the strong force in protons. This is because there is a difference in the bonding strength between the "dd" bond of a neutron and the "uu" bond of a proton [18]. The difference is called weak force. The weak force is classified as an important force that creates the electromagnetic force, but it is not a force that actually exists.

All atomic nuclei have different strengths depending on the number of quark bonds "du", but when one nucleon interacts with an outer nucleon, no strong interaction is involved. Interacting with other nuclei are chiros exposed to the outside of neutrons or protons. When interacting with other nuclei, those chiros do not interact alone. They must pair with other chiros to which they belong, and combine with other nuclei in correspondence with each other. Therefore, there is no bond leaving only one chiro in the newly created nucleon after interaction. When a neutron first appears and then becomes a pro- ton through beta minus decay, the proton combines with a neutron to become a deuteron. The deuteron confines the strong nuclear force of the quark bonds inside the nu- cleon. Deuteron has one d-chiro and one u-chiro outside.

Unlike the quark bonds of normal deuteron, an isotone of deuteron with two d-chiros of a neutron and two u-chiros of a proton can be made, which has quark bonds "du-ud" instead of normal "du-du". This bonds can be made in primitive neutrons and protons, and it is estimated that 1/3 of deuterium nuclei have these bonds [19]. Such bonds cannot be made in helium-2 nuclei (di-protons), which bonds are made between protons.

The proton-proton chain bonding that occurs in a star like the sun creates a helium-2 nucleon (di-proton) by quark bonding, but has two u-chiros exposed on the out-side, which is not a stable quark bond. Thus, one of the four up quarks emits a positron and converts to a down quark, resulting in a stable deuteron. The force interacting the quark bonds is called the strong nuclear interaction, which is confined into the deuteron and does not interact with other particles.

Another bond may be isotopes of helium-2, in which case, 4 u-chiros of 2 protons can be collide with each other. Even if they do react, they cannot combine due to interference of electromagnetic force. This is the reason may be why proton-proton fusion doesn't happen so fast in the sun.

Triton is created by breaking the strong "ud" bond of deuteron and combining it with a neutron. This bond is unstable because it has "udd" chiros on the outside, as in neutrons. Thus, one down quark turns into an up quark and becomes a stable helium-3 nucleon. Helium-3 nucleons are produced not only by the beta minus de-cay of tritons, but also by the combination of proton and deuteron.

A helium-4 nucleon is an atomic nucleon in which all chiros form quark bonds and are completely confined within the nucleon. Since all of the strong nuclear forces generated by quark bonding are confined within the nucleon and there are no chiros to act on the outside, interaction with other atomic nuclei cannot occur except through strong collisions. When a strong collision with another particle occurs, one of the quark bonds is disconnected, and the quarks combine between the colliding particles to form heavy nuclei.

Alpha decay in radioactive elements occurs when a helium particle that does not interact with other particles is created among the particles that are made up the nucleon that is the quark interaction is completely con- fined within the helium so that the strong nuclear force is trapped within the helium. So it can be easily released to the outside of the radioactive element.

Weak force and electromagnetic force field

The neutron produced as a result of quark interaction has two exposed d-chiros and one u-chiro "udd". Among the "du-ud-dd" combinations of quark bonds that create neutrons, the "dd" bonds between down quarks are not stable, causing neutrons to emit electrons and become protons [20]. At this time, the confinement force is converted into a “du-uu-ud” bond and is confined within the proton, changing the combination of forces compared to that of the neutron. Between the “dd” bond of a neutron and the “uu” bond of a proton, the latter bond is more stable. As the result, the difference in the strong nuclear force between the “uu” bond of a proton and the “dd” bond of a neutron results in an additional force that is confined to the proton and the release of electromagnetic force (beta minus decay). This is referred to as the weak force.

When a proton undergoes beta plus decay and trans- forms into a neutron, the quark interaction returns to normal, and the weak force is no longer present. In other words, the weak interaction can create the electromagnetic force, and when the weak force disappears, the electromagnetic force disappears as well. However, the weak force cannot be measured as a separate force. The difference in quark bonding between protons and neutrons causes the strong force to be changed the strength between the two particles, which is a phenomenon that occurs during beta minus decay, and disappears when a proton emits a positron or recaptures an electron and transforms into a neutron.

The beta minus decay path is as follows

$d^- \rightarrow u + W^{*-}$

$n^0 \rightarrow \rho^0 + W^* \rightarrow \rho^+ + e^- + \bar{\nu} e$

Where ρ^0 refers to the neutral state just before it becomes a positively charged proton. Originally, W ± bosons are introduced to explain beta decay, but they are too heavy to be considered a different particle with W^{*-}.

The above W^{*-} has mass deficit energy of 2.5 MeV, which is the energy difference between the down quark and the up quark. The energy equivalent to 1/2 of this energy is used to change the neutron’s quark bond, “du-ud-dd”, into the proton’s quark bond, “du-uu-ud”. At the same time, p0 is converted into positively charged protons ρ^+ using the energy of W^{*-}. Also, the energy is converted into matter with mass, which gives the imp additional mass. Since a new mass is added to the mass of the existing imp, the gravitational field changes, and gravitons are emitted. This is the same process that the primitive imp gains mass.

The remaining 1/2 energy is used to emit electrons and electron neutrinos at the same time as neutrons are converted into positively charged protons, resulting in electromagnetic forces and electromagnetic fields.

In the case of beta plus decay, it proceeds in the reverse order of the beta minus decay. At this time, the decay path is as follows.

$\rho^+ + e^+ + Ve^- \rightarrow \rho^0 + W^{*+} - \rightarrow n^0$

$u^- \rightarrow d + W^{*+}$

In this case, the mass fixed at ρ^+ during beta minus decay and the energy required to create the electromagnetic field are reduced and used to turn the up quark into a down quark. The majority of the energy required by quark interaction to convert the up quark to the down quark is possessed by the proton. Therefore, additional energy is not needed so much. However, it takes a significant amount of energy to convert natural protons into neutrons. According to the beta minus decay, when one of the down quarks of a neutron is converted into an up quark of a proton, the probability of each down quark being converted into an up quark is 1/2. The same is true when the up quark of a proton is converted into a down quark according to beta plus decay.

Neutron era (Temperature: 10^7 K ~ 10^{13} K)

Neutrons born at a high temperature of 10^{10} K are converted into protons by quark interactions. If the neutrons were converted to protons at the temperature of 10^{10} K at which neutrons were born, protons would combine with neutrons as soon as they were born to make deuterons, or create deuterons through proton- proton chain bonding, so there would be no hydrogen atoms left in the universe. In addition, not only helium burning, but all elements were converted to heavy particle elements, which would have made the world different from the present. When a neutron decays into a proton at a temperature of about 10^8 K, the proton created after the decay combines with a neutron or with another proton to form a deuteron. Subsequently, triton, helium-3 nucleons and helium-4 nucleons are also created. If the temperature is slightly higher, it seems that helium fuses with light atomic nuclei to produce lithium, but carbon atomic nuclei may not have been created by helium burning at that time. If neutrons decayed at temperatures lower than 10^7 K, all neutrons would now have been transformed into protons, creating a universe full of hydrogen nuclei. Of course, even in this case, stars could have been born and created baryons to give the universe what is today.

CONCLUSION

When the neutrons created by quark bonding are converted into protons at about 10^8 K due to the instability of quark bonding, protons and neutrons combine to form deuterons, and the neutrons constituting deuterons are stabilized by the strong nuclear interaction of quark bonding to form stable nuclei. Any remaining neutrons will decay over time and be converted into protons. Neutrons in atomic nuclei are confined and remain stable, but, in the case of atomic nuclei with excess neutrons, beta minus decay would occur, converting neutrons into protons. Similarly, in the case of atomic nuclei with excess protons, beta plus decay would occur, creating a neutron. Neutrons can also be emitted as independent neutrons in atomic fusion or nuclear fission and undergo a half-life, eventually converting into protons, or participating in nuclear fusion with other elements.

The conversion of neutrons into protons through beta decay results in the release of electrons, creating soup of electrons and protons, which is called the phase of plasma.

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