On the basic interactions that occur as the early universe evolved: repulsive force, gravity, quark interaction and electromagnetic force.

Tai-choon Yoon[1]

(Dated: Feb. 19th, 2024)

Abstract

The basic forces that govern the universe are repulsive force, gravity, quark interaction, and electromagnetic force. All forces except repulsive force are attractive forces.

Among these forces, repulsive force or expansive force is a force that acts between pure energies, which is the force that dominates the universe. As the universe expands, the temperature decreases and changes into dark energy and dark matter when it reaches $10^{13}K$.

Dark matter is an invisible material called imp (invisible material particle) and consists of imps and quarks. Imp liberates gravity and creates a gravitational field. As the universe continues to expand and the temperature decreases, at $10^{10}K$, an imp interacts with quarks to create neutron, and the force acting at this time is quark interaction. Quark interaction is involved in creating all particles such as neutrons and protons, and is also involved in creating and closing electromagnetic force fields.

Electromagnetic force is a force made by creating an electromagnetic force field inside the proton and emitting electrons during the process of converting neutron into proton. It is also involved in closing the electromagnetic force field during the process of converting proton into neutron.

Keywords: repulsive force, imp, gravity, Lagrangian, quark interaction,
electromagnetic force, the point of the USE

A. Introduction

There are four kinds of interactions that dominate the natural world: repulsive force, gravity, quark interaction and electromagnetic force.

Repulsive force is the force that governs the expanding universe as a force that interacts between energies. The repulsive force and the pressure are basically the same force but in

[1] Electronic address: tcyoon@hanmail.net

opposite directions. Since both are the same force, the repulsive force can be replaced with the symbol of pressure P.

The repulsive force is given by Planck's law, the so-called black body radiation, which is

$$P = \frac{E}{V} = \omega T^4 \qquad \text{(A.1)}$$

where P is the pressure(repulsive force), E is the total energy of the universe, V is the volume of the universe, T is the average temperature of the universe in Kelvin at the time of observation, and ω represents the radiation density constant.

Gravity is an attractive force and follows Newton's laws.

Newton's first law, the law of momentum, is defined as $p = mv$, where p is the momentum, m is the rest mass, and v is the velocity with direction.

Differentiating with respect to time t, we get Newton's second law, the law of acceleration,

$$F = \frac{\partial p}{\partial t} = m\frac{\partial v}{\partial t} \qquad \text{(A.2)}$$

where F is the force, and m is the rest mass.

By integrating (A.2) with respect to displacement x, we get the kinetic energy of a moving object.

$$\begin{aligned} KE = 2\int_0^x F dx &= 2\int_0^x \frac{\partial p}{\partial t} dx \\ &= 2m\int_0^x \left(\frac{dx}{dt}\right) dv \qquad \text{(A.3)} \\ &= 2m\int_0^v v dv = mv^2 \end{aligned}$$

Here, KE represents kinetic energy. The reason we multiply the term on the right by 2 is because the force has a starting point. When two objects pull or push against each other, they exert equal forces on each other in both directions. A force has a starting point, direction, and magnitude. When two forces meet, they become balanced at the point of action. When the starting point and the action point are the same, Newton's third law, the law of action-reaction, explains it well.

If an object is accelerated from $v_1 = v$ to $v_2 = c$, the energy consumed is calculated as follows.

$$\begin{aligned} ME = 2m\int_v^c v dv &= mc^2 - mv^2 \\ &= mc^2\left(1 - \frac{v^2}{c^2}\right) \end{aligned} \qquad \text{(A.4)}$$

Here ME is Lagrangian. mc^2 is the intrinsic energy obtained when the object was created from energy. In other words, when, $v = c$, the object becomes energy and disperses.

Quark interaction is an attractive force that mediates strong interactions. Quark interaction dominates the force that acts to create neutrons through the interaction between imps and quarks, the force that creates an electromagnetic force field as neutron changes into proton, known as beta minus decay, the force that closes the electromagnetic force field as proton changes to neutron, known as beta plus decay, the force involved in protons creating baryons through quark bonding, and the force that alpha particles are liberated from quark interactions and emitted from the atomic nucleus. In other words, quark interaction is an interaction that encompasses previously known as the strong interaction and the weak interaction.

The force of quark interaction occurs in a very short distance and is thus confined within the atomic nucleus. Therefore, the quark interactions confined in each of the neutrons and protons do not participate in the nuclear fusion of neutrons and protons, but new quark interactions between neutrons and protons contribute to the creation of heavy particles.

Quark interaction is an attractive force, so it can be defined as follows,

$$F = Q\left(\frac{xud}{{r_{ud}}^2} + \frac{ydd}{{r_{dd}}^2} + \frac{zuu}{{r_{uu}}^2}\right), \quad 2 \leq x + y + z \qquad \text{(A.5)}$$

where F is the force of quark interaction, Q represents the constant of quark interaction, u and d are masses of each quarks, r_{ik} represents the distance between two quarks and are located within the limit of ($\frac{1}{2}R_{ik} < r_{ik} < R_{ik}$), and 1≤x, 0≤(y, z) are the natural number of quark bonds within a baryon.

Electromagnetic force is the attractive force that appears during the process of neutrons collapsing to create protons.

When a neutron decays to create a proton, an electromagnetic force field is formed inside the proton, and the electromagnetic force field is destroyed in the process of reducing the proton to a neutron.

The four forces reveal in the order of the following:

Repulsive force → Gravity → Quark Interaction → Electromagnetic Force.

When the repulsive force and the gravitational force become equal, the universe will stop expanding,

$$RT = \left(\frac{3GM^2}{2\pi\omega}\right)^{\frac{1}{4}}, \quad T < 1.076 \times 10^{13}K \qquad \text{(A.6)}$$

where R is the radius of the universe, T is the average temperature of the universe in Kelvin, G is the constant of gravitation, M is the total rest mass of the universe, and ω is the radiation density constant.

The current average temperature of the universe is about 32K, so the expansion of the universe will stop at some point within the average temperature reaches 1K from now. However, because there is no power to make the universe hot again, the universe can only stop expanding and cannot re-contract.

B. Big Bang and Repulsive Force (Pressure)

After the Big Bang, the total energy of the universe is neither created nor destroyed according to the law of conservation of energy. However, it is certain that the energy of the early universe before the Big Bang occurred might have been created through unknown path.

If there is a symmetric point based on the occurrence of the Big Bang, it is possible that negative time and negative space contracted and the Big Bang occurred at point 0. However, if energy was scattered in negative space-time and then compressed into a single point and then the Big Bang occurred, we cannot know what the energy was made of. In other words, it implies that point symmetry and chiral symmetry must be broken.

Since Action is 'Energy × Time', differentiating it with respect to time t gives

$$\frac{\partial A}{\partial t} = E_u, \tag{B.1}$$

∂A/∂t has a constant value (E_u) because the total energy is conserved.

In other words,

$$\frac{\partial^2 A}{\partial t^2} = 0. \tag{B.2}$$

$$U(v,T) = \frac{8\pi h v^3}{c^3}\frac{1}{e^{\frac{hv}{kT}} - 1} \tag{B.3}$$

where v is frequency, h is the Planck constant, k is the Boltzmann constant, T is the temperature in Kelvin, c is the speed of light in vacuum.

From this, we get by integrating with respect to v,

$$P = \frac{U}{V} = \omega T^4 \tag{B.4}$$

where P is the pressure, V is the volume of the universe, and ω is the radiation density constant.

In other words, pressure is proportional to the fourth power of temperature.

From the Planck-Einstein relation, we have the following

$$E = hv. \tag{B.5}$$

From the above, we can identify that pure

The early universe consisted only of energy after the Big Bang occurred. As the universe expands, the energy density decreases, and the temperature drops accordingly.

Pressure can be substituted in terms of temperature. Planck's law is a formula for explaining the energy radiated by a black body, and is applicable to the energy-filled universe of the early universe. According to Planck's distribution law, the spectral energy density at given temperature is given as follows.

energy is quantized. As dark energy is the same energy as pure energy, dark energy is also quantized, too.

Based on the temperature $10^{13}K$, the upper part is pure energy and the strongest candidate for pure energy is quantum. And the lower is dark energy and the most remarkable candidate for dark energy is the thermal energy.

Also, according to ideal gas theory, the pressure P is given by:

$$PV = E_u = Nk_B T, \tag{B.6}$$

Here, P is the pressure of the total energy of the universe, V is the volume of the universe, E_u is the total energy, N is the total number of quanta, k_B is the Boltzmann constant, and T is the average temperature in Kelvin.

Differentiating P with respect to displacement x gives

$$dP = \frac{dE}{dV} = \frac{2Fdx}{3x^2 dx} = \frac{2F}{3A}, \tag{B.7}$$

where F is the force and A is the cross-sectional area. That is, the pressure can be calculated by integrating the force and volume respectively.

Therefore, the early universe consists only of energy, and the internal pressure $P = E_u/V$ acts as the repulsive force, causing the universe to expand. The force that governs the universe is the repulsive force (pressure). This refers to the interaction between quanta.

As the universe expands after the Big Bang, the temperature decreases, and at $10^{15}K$ energy particles called top quark and Higgs Particles appear. Top quark changes into bottom quark, charm quark, etc. as the temperature decreases.

C. Creation of Matter and Gravitation

The second most important event in the universe occurs when the temperature reaches $T = 1.076 \times 10^{13}K$, 307 seconds after the Big Bang. That is, matter is created from the energy triggered by the Big Bang as the universe cools. It's like water freezing and turning into ice. It is a phase transition phenomenon of energy. We may call this phenomenon the point of USE (universal solidifying event). The point of USE is the temperature at which energy changes into matter and matter changes into energy.

The material particle appears at the point of the USE. However, not all energy is converted into matter. Therefore, in this state, energy and matter are mixed each other. 1/3 of pure energy becomes a substance called dark matter, and the remaining 2/3 is energy called dark energy. Dark energy is observed when energy cools down, and energy and dark energy are the same energy. Energy has waves in the form of quantum, but it is in a different form from light. Light is like a ship that carries energy. The speed of light does not decrease as the temperature decreases, but the number of waves continues to decrease even though the speed of energy does not decrease, resulting in a form called dark energy.

Now, the newly created material called dark matter, but we now call it imp (invisible material particle). Imp is another name for dark matter and releases gravity upon creation. Dark matter is a collection of material particles with a mass called imp and charm quarks, which are energy particles, and charm quarks have no mass. Immediately after birth, imp releases gravity. From this, a gravitational field is created and gravitational interaction begins. Now, the total energy of the universe (UE) can be divided into dark energy and material energy.

$$UE = DE + ME, \qquad \text{(C.1)}$$

Here, DE is the energy that remains in the early universe without being converted to matter, which is called dark energy, and ME represents the total energy of matter.

ME can be said to be Lagrangian made up of intrinsic energy and kinetic energy. However, there is one more thing to add. That is the heat energy loses from the intrinsic energy as the temperature goes down. To put it conversely, this is the same as a moving object gaining heat and becoming hot.

This can be written as,

$$ME = PE - KE + TE. \quad (C.2)$$

Here, PE represents the intrinsic energy or potential energy, KE is the kinetic energy, and TE is the thermal energy possessed by the moving material.

When the temperature drops, thermal energy is released to the outside of the moving material, and when the temperature rises, the thermal energy is reabsorbed.

The remarkable candidate of dark energy is thermal energy.

The kinetic energy of this energy becomes equal to the intrinsic energy, and when the material disappears, the same amount of energy returns to nature.

From equation (A.4)

$$ME = mc^2 - mv^2 + nTE = mc^2\left(1 - \frac{v^2}{c^2}\right) + nk_BT. \quad (C.3)$$

Therefore, when $v = 0$, $E = mc^2$ becomes zero point energy, and when $v = c$, the material disappears and all energy generated there returns to pure energy, thus complying with the law of conservation of energy.

TE can be written as:

$$nTE = nh\nu = nk_BT. \quad (C.4)$$

Here, n is the total number of quantized thermal energy, the unit quantum number of substance m is $\left(\frac{m}{n}\right)$, and its mass is the mass of an imp.

From this, we can see that moving objects contain quantized thermal energy. A moving object experiences rising temperature by generated heat which, in other word, is the thermal energy supplemented from the outside of the moving object. When $v = c$, the material returns to the energy state, and the amount of energy is $nTE = mc^2$.

Newton's theory of gravitation is given as follows:

$$F = G\frac{m_1 m_2}{r^2} \quad (C.4)$$

From (A.3), we find the gravitational energy of the above

$$E_G = 2\int_r^\infty F dr = 2\int_r^\infty G\frac{m_1 m_2}{r^2} dr = 2G\frac{m_1 m_2}{r} = m_1 v^2. \quad (C.5)$$

From (A.4), substituting $\frac{2GM}{R}$, the escape velocity from the gravitational field, instead of the motion velocity v^2 we have

$$E_G = mc^2\left(1 - \frac{2GM}{Rc^2}\right). \quad (C.6)$$

Here, E_G is the energy in the gravitational field, G is the gravitational constant, and M is the mass of an object escaping the gravitational field, which is equal to m. $2GM = Rc^2$ is known as the event horizon, and from this we can see that the inside of the black hole matters disappear and are converted into pure energy.

D. Creation of Neutrons and Quark Interaction (former strong interaction)

At $T = 10^{15}K$, before imp appears, top quark and Higgs particle, which are energy particles, appear. Top quark releases most of its energy at $4.85 \times 10^{13}K$, which is higher than the point of USE, and turns into bottom quark. Bottom quark changes to charm quark at $1.48 \times 10^{13}K$. Afterwards the charm quark changes into a strange quark, the strange quark changes into a down quark, and the down quark changes into an up quark, and we can see that energy is released and a phase change occurs at each stage.

$T = 1.076 \times 10^{13}K$ is called the point of USE where pure energy is divided into dark energy and imp (dark matter). This temperature is the point at which energy becomes matter, that is, the freezing point, and the point at which matter appears. Just because a new substance appears does not mean that it has been created, just as if water being frozen into ice does not mean that ice was created. Matter is a manifestation of the unique characteristics of energy. Therefore, when the temperature of the substance rises and reaches this temperature, the substance melts and becomes energy.

However, not all energy is converted into matter at the point of the USE. Dark energy is energy that is simply observed as pure energy cools down and takes up 2/3 of the universe. Until now, the energy called dark energy has not been clearly identified, so it was called dark energy . The most remarkable candidate of dark energy is the thermal energy. Therefore, thermal energy is also subject to repulsive force. 1/3 of the total energy is converted into imps. At this time, an imp, an unobservable substance, is created, but since it is a substance that cannot be observed with the eye, it is called dark matter. Early dark matter consists of imps and charm quarks. Imps and charm quarks as well as strange quark do not interact with each other.

An imp meets two down quarks and one up quark at $10^{10}K$ to create an observable particle with a mass called a neutron. This is the third most important event in the birth and evolution of the universe. Matter, unlike dark energy, has the mass and energy it has when it was born, but when the temperature goes down, its thermal energy decreases in proportion to the temperature.

Quark is both an energy particle and a particle with mass. In other words, before combining with an imp, it is an energy particle, but when an imp and quarks interact, it changes into a particle with mass. This is why a neutron is heavier than an imp. Neutrons were born from the combination of imps and quarks, so they have both the masses of imps and quarks. Neutrons become a new substance by combining imps and quarks, but they retain the characteristics of imps and quarks. The force that acts at this time is called the quark interaction. The quark interaction completely replaces the forces called the strong force and the weak force.

Quark is an energy particle, but when it combines with an imp and changes into a neutron, it changes into a particle with mass and generates the strong force. The strong force is confined inside the neutron. The strong force confined inside a neutron is the force created by the three quark bonds of du-ud-dd. Since this binding energy is not stable, the dd bond in the neutron changes to a uu bond and collapses into a stable proton.

When the up quarks and down quarks are depleted, the generation of neutrons stops. Neutrons are created at $2.67 \times 10^{10} K$ and are the first material particles with an observable mass. Imp has gravity, so it may form a cluster and create a black-hole. However, most cluster of imps do not become black holes due to the interference of cosmic repulsion and cool down by emitting thermal energy when the surrounding temperature drops. Observable matters in the universe are known to account for 5% of the total energy.

Quark interaction is a type of an attractive force, so it can be defined as follows.

$$F = Q\left(\frac{xud}{{r_{ud}}^2} + \frac{ydd}{{r_{dd}}^2} + \frac{zuu}{{r_{uu}}^2}\right), \quad 2 \le x + y + z, \tag{D.1}$$

where F is the force of the quark interaction, Q represents the constant of quark interaction, u and d are mass of each quarks, r_{ik} represent the distance between quarks which is located between ($\frac{1}{2}R_{ik} < r_{ik} < R_{ik}$) where R_{ik} represents the radius between the two quarks.

Here x, y, z are natural numbers of quark bonds that arise from the bonding of the chiros that neutrons and protons have on the outside, and each nucleon has different bonds depending on the state in which it is bonded.

Neutrons decay to create protons, and the proton's quark bond du-uu-ud appears to be stronger than that of the neutron.

All elements are created through nuclear fusion of protons and neutrons through quark interaction. The force acting at this time is also called the quark interaction, and is confined inside each element.

Heavy particles determine for themselves, which is more stable depending on the presence or absence of dd bond and uu bond during quark bonding, and the quark bond changes to beta plus decay and beta minus decay, progressing to a more stable nucleus. Chiro that is not used in the fusion process is used to create heavier baryons with other nuclei. In the case of diproton, which is the most basic part of the nuclear fusion, there are two types: one with one ud and one uu, and the other with two uds. They commonly change one proton into a neutron and become a stable deuteron by combining two uds. Triton, which is a combination of two ud and one dd, which is not stable, so it changes to a uu bond to become a stable helium-3.

In the case of helium-4, all chiros are used for quark bonds and are confined within the helium-4 nucleus with only six ud bonds, so it is a very stable nucleus, and fusion with other nuclei requires a lot of energy.

Lithium-6 has one uu bond, making it a stable element. However, Lithium-7 is a stable element even though it has one dd bond. Some elements have both a dd bond and a uu bond, and it is not possible to decide whether they should be changed to a dd bond or a uu bond. Therefore, some cause beta plus decay, and some cause beta minus decay.

The alpha ray, helium-4, by a radioactive element is a phenomenon in which helium-4 liberated from quark interaction during the stabilization process of the atomic nucleus is emitted from the atomic nucleus.

Neutrons were created at $2.67 \times 10^{10}K$, so when the temperature rises again and reaches this temperature, the quark interaction should disappear and separate into imps and quarks, but that doesn't happen.

It is because quark interaction is at work. However, at $1.17 \times 10^{12}K$, which is the temperature at which charm quark is converted to strange quark, quark interaction disappears and neutrons are separated into an imp and a charm quark. When the temperature rises further to $= 1.076 \times 10^{13}K$, imps are converted into energy and the charm quark returns to bottom quark at a higher temperature of $1.48 \times 10^{13}K$.

Mass can be converted into energy only when the mass it possesses is accelerated to the speed of light or the pressure is sufficiently increased to reach the point of the USE, where the mass is converted into energy. This indicates that additional external energy should have been supplied.

In the case of nuclear fission that occurs at room temperature, the residual energy contained in the atomic nucleus contains enough energy to convert the fragments of the atomic nucleus into energy.

Some atomic nuclei emit gamma rays, which are emitted when the residual energy of the atomic nucleus changes its structure into a stable atomic nucleus.

E. Protons and Electromagnetic Force

Neutrons do not interact with neutrons. However, since neutrons are not stable in quark interactions, they are converted into protons with a half-life. The reason why neutrons can be stable within an atomic nucleus is because that they are stabilized by the quark interactions that occur when neutrons and protons combine.

When a neutron converts one down quark into an up quark through quark interaction, $2.5MeV$ of energy is released.

$$\mathrm{d} = \mathrm{u} + W^-$$

In the standard model, this action is called the weak force, and when the down quark collapses to become an up quark, the W^- boson is emitted. W^- bosons are very short-lived and unstable, decaying very quickly.

$$W^- = e^- + \bar{\nu}_e$$

Here, e^- represents the electron and $\bar{\nu}_e$ represents the electron antineutrino.

If this process is correct, the following questions arise:

First, if W^- is a particle with mass, then according to the law of energy conservation, the mass of W^- boson is $2.5MeV/c^2$. An electron with a mass of $0.511MeV/c^2$ is emitted from this particle. At this time, since the electron antineutrino ($< 2.5\mathrm{eV}$) is very light, $\sim 2MeV$ of energy must be released.

Second, if W^- is an energetic particle with no mass, the energy of the W^- boson is $2.5MeV$. At this energy, an electron with a mass of $0.511MeV/c^2$ is emitted. This indicates that particles with mass are created from energy. Even in this case, $\sim 2MeV$ of additional energy must be released.

In reality, it seems clear that the process of neutrons collapsing into protons involves one of the two processes above. However, W^- boson does not intervene. In other words, there is no force called weak force.

This appears to be due to the characteristics of quark. Quark is a particle with energy like quantum, but when it combines with an imp to create a neutron, quark can be said to become a particle with mass at the same time.

One of the down quarks that make up a neutron emits $2.5MeV$ of energy, and when it becomes a proton, an energy gap of $2.5MeV$ must occur. About half of this energy, $1.2067MeV/c^2$ ($2.15 \times 10^{-30}kg = 0.129\%$ mass of proton) constitutes mass, and $0.511MeV/c^2$ of this energy is emitted as mass-bearing electron particles. The remaining energy, $0.7823MeV$, must be emitted, including the electron antineutrino's mass, which is minimal.

However, this energy could have been used to create an electromagnetic force field for the newly created protons. This energy remains in the proton, so it can be called residual energy or residue. This energy is the force that creates and maintains the electromagnetic force field, so it does not cool or decrease even if the temperature decreases. Even if the energy released when the down quark is converted to the up quark is a material particle with a mass of $2.5MeV/c^2$, the result is the same. Therefore, the up quark and down quark that combine with an imp are energy particles that combine with the strong force and change into particles with mass.

This energy is used in the process of converting up quark into down quark to return to neutrons when the electromagnetic field disappears. Therefore, it does not require much energy for the atomic nucleus to convert protons into neutrons on its own. In contrast, it takes a lot of energy to artificially convert protons into neutrons to eliminate the electromagnetic force field.

References

[1] Max Planck, "Ueber das Gesetz der Energieverteilung im Normalspectrum", p. 553 – 563, 1900, URL: http://myweb.-rz.uni-augsburg.de/~eckern/adp/history-/historic-papers/1901-309_553-563.pdf, Access Date: Feb. 04, 2022

[2] Newton's law of motion; https://en.wiki-pedia.org/wiki/, Access Date: Sep. 7, 2023

[3] Transformation of Quark Flavors by the Weak Interaction, http://hyperphysics.phy-

astr.gsu.edu/hbase/Particles/qrkdec.html

Access Date: Feb. 20, 2023

[4] Lagrangian_mechanics, https://en.wikipedia.org/wiki/ Access Date: Dec. 6, 2023

[5] 양성자에도 참(Charm)-쿼크가 생성, 40년 만에 발견, URL: https://-thescience-plus.-com/news/newsview.php?ncode=1065575616288124, Access Date: Oct. 19, 2023

[6] Weird quantum experiment shows protons have more 'charm' than we thought, URL https://www.space.com/protons-charm-quark, Access Date: Oct. 20, 2023

[7] Protons and Neutrons, URL: http://-hyperphysics.phy-astr.gsu.edu/hbase/Part-icles/proton.html, Access Date Aug. 26, 2023

[8] Yoon T.C. "Phase changes and interactions of energy and matter in the universe viewed through temperature change", 2023, http://vixra.org/-abs/2302.0103

[9] Yoon T.C. "Conservation of Mass-Energy and Reinterpretation of the Einstein Field Equations", 2022, https://vixra.org/abs/-2202.0144