

A New Understanding of the Matter-Antimatter Asymmetry

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There are no theory on antimatter structure unless the mirror of its normal matter, with the same mass but opposite qualities such as electric charge, spin, \dots , etc. to its matter counterparts holding with the Standard Model of Particle. In theory, a matter will be immediately annihilated if it meets with its antimatter, leaving nothing unless energy behind, and the amounts of matter with that of antimatter should be created equally in the Big Bang. So, none of us should exist in principle but we are indeed existing. A few physicists explain this puzzling thing by technical assuming there were extra matter particles for every billion matter-antimatter pairs, or asymmetry of matter and antimatter in the end. Certainly, this assumption comes into beings by a priori hypothesis that the matter and antimatter forming both complying with a same composition mechanism after the Big Bang, i.e., antimatter consists of antimolecules, antimolecule consists of antiatoms and antiatom consists of antielectrons, antiprotons and antineutrons without experimental evidences unless the antihydrogen, only one antimolecule. *Why only these antimatters are detected by experiments? Are there all antimatters in the universe?* In fact, if the behavior of gluon in antimatter, i.e., antigluon is not like the behavior but opposites to its matter counterparts or reverses gluon interaction \mathcal{F}_{g^k} to $-\mathcal{F}_{g^k}$, $1 \leq k \leq 8$ complying with the Standard Model of Particle, then the residual strong interaction within hadrons is repulsion. We can establish a new mechanism of matter and antimatter without the asymmetry assumption but only by composition theory of matter, explain the asymmetry of matter-antimatter and why only these antimatters found, claim both the attractive and repulsive properties on gravitation. All of the conclusions are consistent with known experiments on matter and antimatter.

1 Introduction

Antimatter and dark energy are both physical reality in the universe. An antimatter is literally, a mirror image with the same mass but reversed electrical charges and spin as its correspondent normal matter such as those of positrons, antiprotons, antideuteron, \dots and antihydrogen. The most interesting phenomenon on antimatter \bar{M} is that if it collides with its normal matter M will completely annihilate into energy E in global energy shortage today. For example,

$$e^- + e^+ \rightarrow \gamma + \gamma,$$

i.e., an electron e^- collides with a positron e^+ will completely transforms to 2 photons γ , an energy form.

Antimatter was first theoretically considered by Paul A.M.Dirac in 1928 for his equation $E = \pm mc^2$ which allowed for the negative energy existence, correspondent to anti-particles in the universe. And then, Carl Anderson discovered positron, the first evidence that antimatter existed in 1932. A few famous things signed the founding of antimatter \bar{M} are listed following ([2],[3]):

- (1) Positron by C. Anderson in 1932;
- (2) Antiprotons by E. Segrè and O. Chamberlain et al at Bevatron of Berkeley in 1955;

(3) Antineutron by B. Cork et al at Bevatron of Berkeley in 1957;

(4) Antideuteron by Antonino Zichichi et al at CERN in 1965;

(5) Antihydrogen by W. Oelert et al at CERN in 1995.

In fact, modern physics convinces that there exists elementary antiparticle for every elementary particle ([4]), founded in its decay, scattering and radiation such as those known rulers following:

(1)(β -Decay) $n \rightarrow p + e^- + \bar{\nu}_e$, i.e., a neutron n can spontaneously decays to a proton p , a electron e^- and antineutrino $\bar{\nu}_e$;

(2)(Scattering) $\gamma + \gamma \rightarrow e^- + e^+$, i.e., a photon γ collides with another γ will scattering an electron e^- and a positron e^+ ;

(3)(Radiation) $e^- \rightarrow e^- + \gamma$, i.e., a high level electron e^- jumps to a low level e^- will radiating a photon γ .

For explaining the observation that the universe is expanding at an accelerating rate, the dark energy is suggested in the standard model of cosmology in 1998 ([15]). But, neither its detecting nor forming mechanism is hold by humans unless it contributes 68% energy to the total energy in the observable universe. *Where does*

it comes from and how is it formed? Certainly, the dark energy and antimatter are both related to Big Bang but we have no a theory for explaining their born and rulers in universe. The key point is holding on the forming of antimatter with action on matter.

Usually, antimatter is understood as the mirror of its normal matter with the same mass but opposite qualities such as electric charge, spin, ···, etc. to its matter counterparts, holds with the Standard Model of Particle, and a priori hypothesis that the matter and antimatter forming both comply with a same composition mechanism after the Big Bang by humans, i.e., a matter consists of molecules, a molecule consists of atoms, an atom consists of electrons, protons and neutrons, ···, and an antimatter also consists of antimolecules, an antimolecule also consists of antiatoms, an antiatom also consists of antielectrons, antiprotons and antineutrons, ···, respectively, a mirror composition theory on antimatter ([17]). However, there are no antimatter unless elementary antiparticles, and only one antimolecules, i.e., antihydrogen found by experimental evidence. Then, *why only these antimatters are detected and where are other antimatters hidden, or there are no other antimatters?* Furthermore, *could we claim the composition mechanism of antimatter is the same that of matter?* We can certainly not unless only by purely imagination. The central factor is the behavior of antigluon in antimatter. Clearly, gluon is an attraction in the composition of normal matter by the Standard Model of Particle. But, *is antigluon only an attraction, or its counterpart, a repulsion?* By its action property, antigluon should be a repulsion, not a mirror of a normal gluon complying with the Standard Model of Particle.

However, if the action of antigluon is a repulsion, we can easily explain why we exist, naturally abandoning the asymmetry assumption and understanding well the material constitution. We can therefore establish a new mechanism of matter and antimatter without the asymmetry assumption but only by composition theory of matter, explain the asymmetry of matter-antimatter and the scenery behind the Big Bang. We also discuss the property of gravitation between matters, antimatters, i.e., attraction and repulsion, the source of dark energy and clarify a few confused questions on applying antimatter in this paper.

2 Antimatter's Composition

2.1 Antimatter's Quark Structure

As is well known, atoms appear as a building block of all matters with a microcosmic structure, i.e., a nuclei consisting of electrons, protons and neutrons, ···, etc.. Notice that the action in QCD is an integral of Lagrangian

density over space-time following

$$S_{QCD} = \frac{1}{4} \int d^4x F_{\mu\nu}^k F^{k\mu\nu} + \int d^4x \bar{q} (\gamma^\nu D_\nu + m_q) q$$

where, the first term is the gluon interaction described by the field strength tensor F_μ^k , where

$$\begin{aligned} F_{\mu\nu}^k &= \partial_\mu F_\nu^k - \partial_\nu F_\mu^k + g_s \lambda_{ij}^k F_\mu^i F_\nu^j, \\ D_\mu &= \partial_\mu + i g_s F_\mu^k \lambda_k \end{aligned}$$

and the second term is the quark action with quark mass m_q . In the Standard Model of Particle, baryons such as those of the proton and neutron are bound of 3 quarks q and antiquarks \bar{q} , and mesons including gluon, W and Z particles consist of a quark q and an antiquark \bar{q} , explains the strong and weak force well in an atom.

Notice that gluons are carrier of the strong interaction in the Standard Model of Particle, which is attraction of quarks in hadrons such as those shown in Fig.1

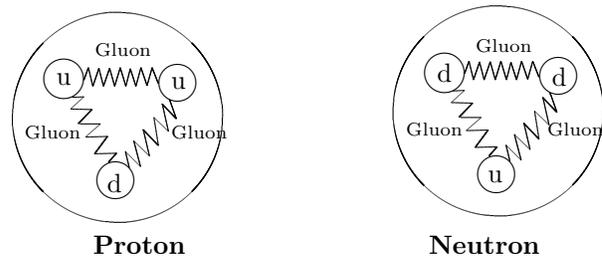


Fig. 1

and each quark or antiquark carries one of red r , green g , blue b or antired \bar{r} , antigreen \bar{g} , antiblue \bar{b} , i.e., color-charges resulting in 8 gluons listing following which characterizes strong interaction of quarks with exchanging gluons

$$\begin{aligned} g^1 &= r\bar{g}, \quad g^2 = r\bar{b}, \\ g^3 &= g\bar{b}, \\ g^4 &= \frac{1}{\sqrt{2}} (r\bar{r} - b\bar{b}), \\ g^5 &= g\bar{r}, \quad g^6 = b\bar{r}, \quad g^7 = b\bar{g}, \\ g^8 &= \sqrt{6} (r\bar{r} + b\bar{b} - 2g\bar{g}). \end{aligned} \tag{2.1}$$

Moreover, g^i is an attraction if $R_1 < r < R_2$, and a repulsion if $r < R_1$ for integers $1 \leq i \leq 8$ by experiments ([5]) such as those shown in Fig. 2

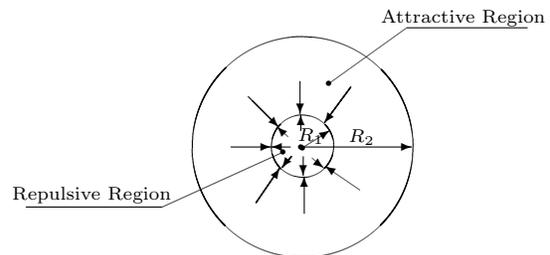


Fig. 2

where r is the distance of 2 quarks and $R_1 = 5 \times 10^{-14}$ cm, $R_2 = 4 \times 10^{-12}$ cm are respective the attractive, repulsive radius of quark.

Clearly, the composition theory of matter by quarks and gluons are essentially the new globally mathematical elements introduced in [14], i.e., continuity flows and discussed extensively on their mathematical characters in [9]-[13], or combinatorial geometry in [5]-[8].

Noticed that one Yin (Y^-) and one Yang (Y^+) constitute everything of universe in Chinese culture. We therefore know that there maybe 2 kind assumptions on the behavior of gluons hold with the Standard Model of Particle in the region $R_1 < R_2$ following:

Attraction Assumption. In this case, the composition of antimatters is the same as the ruler of matters, i.e., antimatter consists of antimolecules, antimolecule consists of antiatoms and antiatom consists of antielectrons, antiprotons and antineutrons. However, there are no such composition evidences unless one antimolecule, the antihydrogen \bar{H} , and all other composition matters are not found until today. In fact, such a composition mechanism only is a wishing thinking of humans with a priori hypothesis that all antigluons are attractive with the same color-charges (2.1) that of gluons, and the residual strong interaction within hadrons and antihadrons is attraction which forms the matter and antimatter. However, experimental evidences allude that the reality maybe not this case, resulting in the next assumption.

Repulsion Assumption. In this case, antigluons are all repulsive or interactions \mathcal{F}_{g^i} listed following

$$\left\{ \begin{array}{l} \mathcal{F}_{g^1} = -\mathcal{F}_{g^1} = -\mathcal{F}_{r\bar{g}}, \\ \mathcal{F}_{g^5} = -\mathcal{F}_{g^5} = -\mathcal{F}_{g\bar{r}}, \\ \mathcal{F}_{g^2} = -\mathcal{F}_{g^2} = -\mathcal{F}_{r\bar{b}}, \\ \mathcal{F}_{g^6} = -\mathcal{F}_{g^6} = -\mathcal{F}_{b\bar{r}}, \\ \mathcal{F}_{g^3} = -\mathcal{F}_{g^3} = -\mathcal{F}_{g\bar{b}}, \\ \mathcal{F}_{g^7} = -\mathcal{F}_{g^7} = -\mathcal{F}_{b\bar{g}}, \\ \mathcal{F}_{g^4} = -\mathcal{F}_{g^4} = -\mathcal{F}_{\frac{1}{\sqrt{2}}(r\bar{r}-b\bar{b})}, \\ \mathcal{F}_{g^8} = -\mathcal{F}_{g^8} = -\mathcal{F}_{\sqrt{6}(r\bar{r}+b\bar{b}-2g\bar{g})}. \end{array} \right. \quad (2.2)$$

where \mathcal{F}_{g^i} denotes interaction of gluon g^i for integers $1 \leq i \leq 8$. Notice that (2.2) will finally results in a repulsion of residual strong interaction within antiprotons and antineutrons such as those shown in Fig. 3.

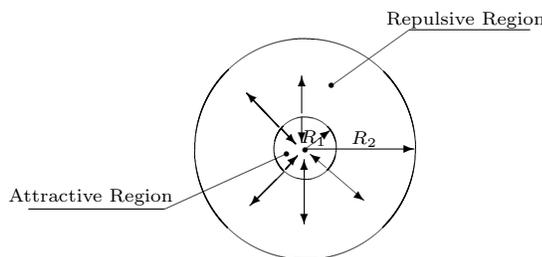


Fig. 3

Although we have also no experimental evidences on the repulsive behavior, likewise the attraction assumption on antigluons, we can explain the behavior of antimatters and the source of dark energy in the universe well by this assumption.

2.2 Antigluon's Repulsive Behavior

Let R_1, R_2 be the attractive, repulsive radius of a quark, respectively and let r be the distance to the center of a quark. We know the interaction behavior of gluons, antigluons $g^i, \bar{g}^i, 1 \leq i \leq 8$ by Fig.2 and Fig.3 following.

Particle Name	$r < R_1$	$R_1 < r < R_2$	$r > R_2$
Gluon	Repulsion	Attraction	0
Antigluon	Attraction	Repulsion	0

Table 2.1

Whence, the residual strong interaction within an antiproton or an antineutron is repulsive, and an antiproton can not be bound with an antiproton, an antiproton can not be bound with an antineutron, and an antineutron can not also be bound with an antineutron in theory. We should discuss the residual strong interaction \mathcal{F} combining with electromagnetism in detail. Let $D(p_1, p_2)$ be the minimum distance of 2 particles p_1, p_2 . Then, by the ruler that like charges repel but unlike charges attract each other in nature, we easily know that

$$\left\{ \begin{array}{l} D(\bar{p}_1, \bar{p}_2) > 0 \text{ if } p_1, p_2 \text{ both are antiproton;} \\ D(\bar{p}_1, \bar{p}_2) \geq 0 \text{ if one of } p_1, p_2 \text{ is antineutron,} \end{array} \right. \quad (2.3)$$

which implies that the minimum distance > 0 for 2 stable antiprotons, ≥ 0 for a stable antiproton with a stable antineutron or 2 stable antineutrons.

2.2.1 Antimatter's Combination Mechanism

Surely, the repulsive property of antigluons generates the antimatters following.

Antinucleon. We are easily know that there are no other stable antinucleon unless antiproton \bar{P} , antineutron \bar{N} by the antigluon's behavior because the residual strong interaction of antiprotons, antineutron is repulsive, i.e., there are no stable antinucleon composed of more than 1 antiprotons or an antiproton with antineutrons.

Certainly, A.Zichichi et al at CERN of European and L.Redman et al at Brookhaven of USA artificially synthesized antideuterium \bar{D} in 1965 which is consisted of an antiproton and an antineutron, and also followers such as those of antitritium nucleon \bar{T} , antihelium nuclei \bar{He} , \dots , etc. In fact, all of these antinucleons are made in laboratory with high energy but not stable, i.e., they

exist only a short time. *Why this happens?* It is subjectively explained by the notion that the antinucleon was finally annihilated with its nucleons counterpart. However, there are no experimental evidence for this explaining, and there are no such an annihilation observed but only the graspable feature of antinucleon disappeared from the eyes of humans.

This phenomenon can be explained naturally by the repulsive property of antigluons. Certainly, an antiproton can composed with antiprotons, antineutrons initially under the bombing of particle beam of high energy. However, as soon as an antinucleon forms, i.e., $D(p_1, p_2) < 0$ for antiparticles p_1, p_2 consisting of the antinucleon, the the residual strong interaction within the antinucleon acts on each antiparticle. It is repulsive. It will spontaneously separates antiparticles until $D(p_1, p_2) \geq 0$ for all of them, never needs the assumption that they are annihilated with their nucleon counterparts.

Antimolecule. A nucleon captures electrons to balance charges, and similarly, an antinucleon also captures positrons to make charge balance in theory, i.e. antimolecule. Thus, an antiproton \bar{P} , an antideuterium nucleus \bar{D} , an antitritiu nucleus \bar{T} or generally, an antinucleon can be bound with one positron to produce antihydrogen \bar{H} , antideuterium \bar{D} , antitritiu \bar{T} , and generally, bound with positrons for balancing charges in the antinucleon to produce antimolecule \bar{M} because the nuclear force between antinucleon and positrons is electromagnetism, an attractive force.

However, all of these antimolecules \bar{M} are unstable unless the antihydrogen \bar{H} because of the repulsive property of antigluons. Thus, even we can artificially synthesize antimolecules $\bar{M} \neq \bar{H}$ in high energy, \bar{M} will spontaneously disintegrates to antihydrogen \bar{H} or antineutrons one by one, such as those shown in Fig.4 for an antideuterium \bar{D} in the universe.

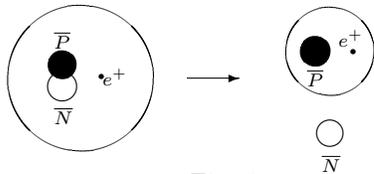


Fig. 4

Whence, an antimolecule \bar{M} is unstable if $\bar{M} \neq \bar{H}$. It can only exists in high external pressure for resisting the repulsion of residual strong interaction. We summary the states of antimolecules Table 2.2.

\bar{M}	Existing	State	Synthesized
$\bar{M} \neq \bar{H}$	High energy	Unstable	No
\bar{H}	Usual condition	Stable	Yes

Table 2.2

Indeed, W.Oelert et al artificially synthesized a few antihydrogens at CERN in 1995 but these antihydrogens only exist in 4×10^{-8} s ([2]), seems likely to contradict the stable behavior of antihydrogen listed in Table 2.2. *How do we explain this case?* Notice that the experiment of W.Oelert et al verified that all antihydrogens are annihilated with hydrogens, not appearing of an unstable behavior, i.e.,

$$\bar{H} + H \rightarrow \text{Energy}$$

because our earth is full of hydrogens, consistent with Table 2.2. Thus, we can classify known and unknown but maybe existing antimatters in Table 2.3.

\bar{M}	External Energy	State	Verified
e^+	Usual energy	Stable	Yes
\bar{P}	Usual energy	Stable	Yes
\bar{N}	Usual energy	Stable	Yes
\bar{H}	Usual energy	Stable	Yes
Antideuteron	High energy	Unstable	Yes
$\bar{M} \neq \bar{H}$	High energy	Unstable	No

Table 2.3

As is well-known, positron was found in constituents of cosmic rays, and we can imitate the Big Bang and get antimatters in high energy laboratory. However, they are unstable unless antiprotons, antineutrons and antihydrogens implied by Repulsion Assumption in Table 2.3. Then, *where are the hiding places of antimatters $\bar{M} \neq \bar{H}$ in the universe?* Theoretically, we are easily to get stable antimatters likewise to pick up a small stone on the earth but unstable antimatters can be only obtained in the situation of high energy, i.e., near or in fixed stars or high energy laboratory hold with

$$\mathcal{F}_{\text{epf}} > \mathcal{F}_{\text{rsa}}, \tag{2.4}$$

where \mathcal{F}_{epf} , \mathcal{F}_{rsa} are respectively the external pressure force and the residual strong interaction within antiproton or antineutron of repulsion. Certainly, the equation (2.4) also explains the reason that why it is hard to get an antimatter $\bar{M} \neq \bar{H}$ in the laboratory of humans because it needs higher energy \mathcal{F}_{epf} to bind antiprotons and antineutrons and we have no such a powerful laboratory until today. But, *why are we also hard to get antiprotons and antineutrons on the earth, both of them are stable?* It is because the earth is full of protons and neutrons, or matters, which results in the transiently existing of antiproton and antineutron after they come into beings in the laboratory.

Then, *where is the stable antimatter and why can we not find them outside laboratory unless the positron?* All

stable antimatters should be far away from galaxy. Otherwise, they will be annihilated with their counterparts matter. Thus, stable antimatters can be only existing in intergalactic spaces. There may be 2 existing forms of antimatters following:

C1. Free Antimatter. The free antimatter includes free positron, free antiproton, free antineutron and free antihydrogen. They are floating on space one by one, and if one of them collides with its matter counterpart it will annihilates into repulsive energy, which will further separates free antimatters to avoid collision again and finally, stable.

C2. Antimatter Star. The antimatter star includes antiproton star, antineutron star, antihydrogen star or their combination. As it is well-known, there are matters such as those of oxygen, nitrogen, argon, carbon dioxide, hydrogen and other matters in space but no proton stars, and an antimatter on the star may be collided with its matter star into annihilation. However, an antimatter star will be finally stable because if $D(\bar{p}_1, \bar{p}_2) \geq 0$, the residual strong interaction between antiparticles \bar{p}_1 and \bar{p}_2 is $\mathbf{0}$, i.e., stably existed. And *why can they not be annihilated with their counterparts matter completely?* Affirmatively, antimatters on surface of the star will be annihilated with their matter counterparts. But, as soon as the annihilation happens, a repulsion energy between the matter and antimatter star appears, which will finally pushes the matter and antimatter away until their distance $D(p, \bar{p}) > 0$ and forms a neutral space. A simple calculation enables us knowing respectively the upper density d_p, d_n and d_c of antiproton star, antineutron star and other antimatter stars as follows:

$$\begin{aligned} d_p &\leq \left(\frac{1}{16 \times 10^{-16}} \right)^3 \times (1.6726231 \times 10^{-27}) kg/m^3 \\ &= (2.44140625 \times 10^{44}) \times (1.6726231 \times 10^{-27}) kg/m^3 \\ &= 4.08355249 \times 10^{17} kg/m^3, \\ d_n &\leq \left(\frac{1}{6.8 \times 10^{-16}} \right)^3 \times 1.6749286 \times 10^{-27} \\ &= (3.18033788 \times 10^{45}) \times (1.6749286 \times 10^{-27}) \\ &= 5.32683887 \times 10^{18} kg/m^3, \\ d_c &< 5.32683887 \times 10^{18} kg/m^3. \end{aligned}$$

3 Matter-Antimatter's Scenery Behind the Big Bang

Certainly, antimatter formed accompanying with matter after the Big Bang, i.e., the universe exploded into a seething fireball consisting of equal particles and antiparticles, and radiation. And then, the universe expanded rapidly, cooling in the process, and finally the matter and antimatter formed, which is in accordance with the

sentence: *All things are known by their beings, and all beings come from non-beings* in Chapter 40 of TAO TEH KING, a well-known Chinese book written by Lao Zi, an ideologist in ancient China. We are able to build up a scenery of what happened, i.e., the forming of universe after the Big Bang ([16]) following.

STEP 1. Around 10^{-34} seconds, the universe burst its banks in a rush of expansion, growing at an exponential rate, i.e., inflation. During this period, energy, first repulsion and then, attraction were created to fill the expanding universe, which are the source of matter and antimatter in the universe.

STEP 2. Around 10^{-10} seconds, both of the strong repulsive and attractive force separated out. The pairs of quark and antiquark, the gluon and antigluon would have moved freely about in a very hot state called a quark-gluon or antiquark-gluon plasmas. By the hot pressure originated from the Big Bang, antimatter first come into being with a process that antiquark-gluon plasmas were composed to antiprotons, antineutrons and antiatoms as they captured positrons, and then antimolecules or antimatters one by one.

STEP 3. In about 10^{-7} seconds, the universe had cooled enough for the quark-gluon plasma to convert into the proton, neutron, and antimatter be spontaneously separated to antihydrogens, antiprotons, antineutrons under the residual strong interaction within an antiproton or an antineutron at the same time. All of them were freely floating.

STEP 4. Around 1 second, a few pair of matter and antimatter such as those of electron and positron, proton and antiproton, neutron and antineutron were annihilated into repulsive energy when they collided and then, pushed the matter and antimatter away until a neutral space appeared. Otherwise, the antimatter freely floated with its counterpart matter in the space.

STEP 5. Once the universe was a few seconds old, it became cool enough for the combination of protons and neutrons to form hydrogens, heliums, and antimatter were separated to antihydrogen, antiprotons, antineutrons, and positrons were thrown out from antimolecules. Certainly, it may be annihilated if the hydrogens, heliums collided with antihydrogen or antihelium existed in this time.

STEP 6. In about half an hour after the Big Bang, the amount of matter settled down but was constantly battered by the huge amount of light radiation, and in the meanwhile, antimatter stars were formed along with the cosmic inflation by their repulsion of interaction. Free antimatter also exists if they were not annihilated with its counterpart matter.

STEP 7. In about 3×10^5 years, the universe had become dilute and cool enough for light to go its own way unimpeded. More atoms and molecules started to form

by nuclei capturing electrons, and matter was born gradually, and antimatters were stable unless free positrons, which will annihilated if they collided with electrons.

STEP 8. In about 10^9 years, there began to form stars, fixed stars, planets, and appearing lives with existed stable antimatters in the universe. After 1.37×10^{10} years apart from the Big Bang, the universe evolves at its present visible and observable state, both including matters and stable antimatters.

Although antiproton or antineutron stars have not been determined by humans today, they are indeed existing and will be found in the universe someday.

4 Application's Preconditions

As we discussed, there are no antimatter likewise matters on the earth and there are no stable antimatter unless free antimatter such as those of positrons, free antiprotons, free antineutrons, free antihydrogens and antimatter stars, i.e., antiproton star, antineutron star or their combination in universe. It is completely different from the normal matter's world. There are no possibility for the birth of living antibeings, no antipeoples, and it is only a symmetrical mirror of elementary particles but with a different mechanism on composing antimatters.

Certainly, the most interested character for humans today is that antimatter can be completely annihilated into clean energy if it collides with its counterpart matter, without any waste left over. However, where and how to extract it, and how to reserve it are 3 typical problems should be solved before its universal applied.

Problem 1. Antimatter Searching. By the repulsion assumption, one could find antimatter only in its 2 states following.

1. **High Energy.** In this case, there are 2 places maybe find antimatter, i.e., the place in or near fixed stars in universe and the high energy laboratory. As we known, all materials made by humans technology can not arrive at any fixed stars unless new high heat resistant material be created someday. Certainly, we can artificially synthesize antimatter in laboratory but only get very little used for scientific research, and the energy needed for synthesized antimatter is far exceeding the energy of annihilation, can not be universal applied for humans ([1], [2]).

2. **Stable.** The stable antimatter includes free antimatter and antimatter stars. The former is sloppy, freely floating without a fixed position in space. Thus, it is also difficult to collect a good supply of antimatter in this case. However, antiproton, antineutron or their combination star may be a good resource for getting plenty of antimatter in universe, extracted for application.

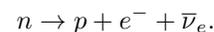
Problem 2. Antimatter Extracting. There are

2 preliminaries for extracting antimatter from an antimatter star. One is to determine its accurate position in space. Another is developed such a spaceship that can arrive at the antimatter star with mining tools. Notice that such a spaceship can not landed on and we can not excavate antimatter from such an antimatter star like-wise mining in the earth. Otherwise, the repulsion of residual strong interaction within antiprotons and antineutrons will push it away from the star, i.e., a maybe extracting is the spaceship close to the antimatter star as possible and mines antimatter like scooping water in a pond by a spoon, on which there is a layer pushing away matter and antimatter on surface.

Problem 3. Antimatter Retaining. Clearly, it is difficult to retain antimatter in a container made by normal matter because antimatter will annihilates with the normal matter. Generally, the researchers construct an electromagnetic field between antimatter and normal matter to separate them for retaining antimatter in laboratory, i.e., Penning trap. However, it only exists in a very short times in this way. For example, the antiproton only exists in less than 1 second in 2010, and 16 minutes in 2016 at CERN ([1]). There are no possible for applying antimatter to humans in such a retaining way.

Notice that an antiproton will annihilates and produces repulsive energy if it collides with a proton. We can construct a closed container filled with uncompressed hydrogens for retaining a mount of antiproton if its wall is strong enough to resist the repulsive energy produced in the annihilation of surface antiprotons with protons in all H 's, where, it is assumed that the number of hydrogen is equal to that of antiprotons on the surface of extracted antiprotons.

Similarly, we can construct such a closed container for retaining antineutron if its wall material is stable without neutrons in theory. However, it is more difficult for retaining antineutron because of the β -Decay, i.e.,



5 Further Discussions

There are a few topics related with antimatter further discussed following which are all important for understanding our universe.

Unmatter. By definition, unmatter is neither matter nor antimatter but something in between such as those of atoms of unmatter formed either by electrons, protons, and antineutrons, or by antielectrons, antiprotons and neutrons discussed in [19],[20]. However, there are no stable unmatter if the repulsion assumption on anigluon is true because there are no matters when antimatter appeared after the Big Bang, and as the matter

turned up, the repulsion forced antimatters to decompose into positrons, antiproton, antineutron, antihydrogen, blocked their combination naturally, and if they collided with their counterpart matter, they will annihilated into energy. Even if they combined on condition they are unstable and break down into elementary antiparticles and normal matter in a very short time. Whence, unmatter can be only found by artificially synthesized in high energy laboratory.

Gravitation. As it is well known by Newton, there exists universal gravitation $F = G \frac{m_1 m_2}{r^2}$ in 2 normal particles with masses m_1, m_2 respectively, where r is the distance of the 2 particles and G the constant of gravity, and Einstein understood it by space curvature ([7]). But, *what is it about antiparticles? Is it also attractive?* As we discussed, if the behavior of antigluons is repulsive, the residual strong interaction within hadrons is repulsive, and the gravitation between 2 antiparticles should be contrary to the attractive, i.e., the repulsive $F = -G \frac{m_1 m_2}{r^2}$ for 2 antiparticles with masses m_1, m_2 in distance r . We then have the behaviors of gravitation in particles and antiparticles following:

- (1) **Attractive** in 2 normal particles;
- (2) **Repulsive** in 2 antiparticles;
- (3) **Equilibrium** in an antiparticle and its normal particle with an equilibrium distance in space.

Obviously, such gravitational behaviors can be also characterized by properties of space curvature.

Dark Energy. Clearly, the dark energy exists only in a repulsive behavior for the observed accelerating universe, without substantial evidence ([15]). *Where does it comes from? And what is its acting mechanism? Why we can not hold on the dark energy is because we always understand the universe by its normal matter with an assumption that antimatter is only a mirror and follows the same rules of matter, only a partial view and results in the asymmetry of matter and antimatter. However, if we stand on a whole view, we can conclude that the dark energy naturally originates from antimatter's, i.e., antiproton's and antineutron's repulsion.*

Conclusively, the Big Bang produced the equality of particles and antiparticles but different forming mechanisms, i.e., attractive and repulsive with the 4 known fundamental forces, respectively on matter and antimatter, which formed the universe, observable or unobservable by humans today.

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