Transition of Expansion acceleration of the Universe through Negative Mass

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This letter explains that density of positive mass and negative mass is almost uniformly throughout the whole universe, but density of positive mass and negative mass included in a random universe radius R can be different from each other. Like this, positive, zero, negative values of total gravitational potential energy are all possible due to density difference of positive mass and negative mass included in a random universe radius R. This letter is showing possibility in explaining the decelerating expansion and accelerating expansion due to density difference of positive mass and negative mass because negative mass and positive mass conducts different forms of movement depending on the density difference of positive mass and negative mass. As change of total gravitational potential energy sign occurs from U_T=0 and total gravitational potential energy oscillates based on 0. This provides valid explanation regarding to the problems of the flatness of the universe and fine tuning.

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I. Introduction

In the previous paper [1] which we supposed the pair creation of negative mass and positive mass in the early universe, we proposed the possibility to explain various problems of cosmology such as dark matter, dark energy, fine tuning of mass density, acceleration expansion of the universe and etc.

In this letter, we look into another possibility of one of the fundamental contents a model that is needed in explaining the universe, accelerating expansion(inflation) - decelerating expansion(until approximately 70 - 50 billion years ago) - recent accelerating expansion of the universe, through pair creation of negative mass and positive mass.

ΛCDM hypothesis, which is receiving the most support in current cosmology, explains dark energy through cosmological constant and supposes vacuum energy as the origin of this cosmological constant. [2] [3] This model suggests that as the size of vacuum energy grows and as that accelerating expansion accelerates, the universe expands exponentially and that every galaxy will meet big rip condition. [2] [3]

In the previous paper [1], we proposed a method to explain acceleration change that ranges throughout the whole history of the universe with the negative mass model. Although this method can qualitatively explain acceleration change throughout the whole history of the universe, it seems as it is an assertion that threatens the strong mass-energy equivalence law that "all energy is totally equivalent to mass" and that "all energy has a role as a gravitational source."

Even if it isn't a photon and if there was a change in the density of positive mass which has a role as a gravitational source for some reason, it proposes a possibility to explain the expansion acceleration change of our universe.

Therefore this letter proposes another method to qualitatively explain expansion acceleration change of the universe and through this method, explains acceleration change throughout the total time of the universe and tries to propose a prediction of the current and future image of the universe.

II. The property of total potential energy

According to the results of the previous paper, [1] you can see some tendency in total potential energy following the difference between the number(proportioned to density) of negative mass and positive mass.

When the number of negative mass is n_-, and the number of positive mass is n_+, total potential energy is given as follows.

$$U_T = \sum_{i,j}^{i=n_-,j=n_+} \left(\frac{Gm_{-i}m_{+j}}{r_{-+ij}}\right) + \sum_{i,j,i>j}^{i,j=n_-} \left(\frac{-Gm_{-i}m_{-j}}{r_{--ij}}\right) + \sum_{i,j,i>j}^{i,j=n_+} \left(\frac{-Gm_{+i}m_{+j}}{r_{++ij}}\right) \quad (1)$$

$$U_T = (n_- \times n_+)\left(\frac{Gm_-m_+}{\bar{r}_{-+}}\right) + \left(\frac{n_-(n_--1)}{2}\left(\frac{-Gm_-m_-}{\bar{r}_{--}}\right) + \frac{n_+(n_+-1)}{2}\left(\frac{-Gm_+m_+}{\bar{r}_{++}}\right)\right) \quad (2)$$

For the analysis of the property, we assuming that all mean distance are same value, and negative mass and positive mass has a same unit mass.

We can see the change in total potential energy in accordance with the difference in the number of negative mass and positive mass. $U_- = -U_+$, n_-= 10, $n_+ = 1$ 20)

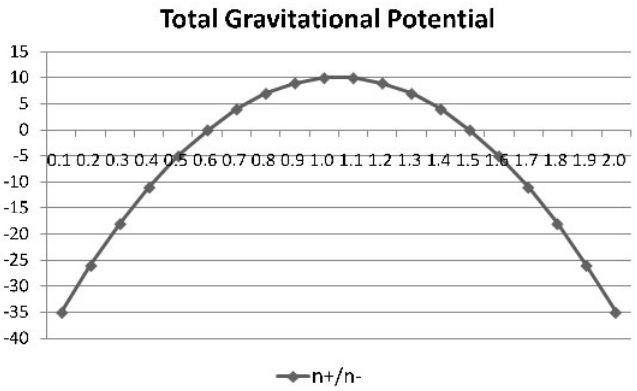

Figure 1: Total gravitation potential from ratio of negative mass and positive mass

1.The tendency of total potential energy in accordance with the number(density) of negative mass and positive mass [1]

1) In critical ratio of the number(or density) of negative mass to the number(or density) of positive mass, the total potential energy has 0. The universe is flat.
Ex. (n_-,n_+) = (10,6),(10,15)

Here, we note that total potential energy does not have 0 when general matter comes under 60%, 150% of dark matter. 60% and 150% are the proportion by assuming that all terms of potential energy are identical, and prescribing that the number of n_- is 10.

2)If number (density) of positive mass and negative mass have a critical range, total potential energy has positive value. Cosmic accelerating expansion
Ex) $0.6 < n_+/n_- < 1.5$)

3)The ratio of positive mass and negative mass has a negative value of total potential energy in the deviating section from the section described in 2). Decelerating expansion of positive mass. decelerating expansion of the universe.
Ex) $n_+/n_- < 0.6$ or $n_+/n_- > 1.5$

4)The value of total potential energy increases as the number of positive mass approaches to the number of negative mass.

5)If the number of pair of negative mass and positive mass is n, n terms of positive potential remains as shown in equation (72). At this time, total gravitational potential has a maximum value.

$$U_n = \sum_{i=1}^{n^2} U_{+i} + \sum_{j=1}^{n(n-1)} U_{-j} = nU_+ \quad (3)$$

In cases when the size of average gravitational potential term between particle pairs(++,- -, -+ pairs) is different, it is guessed that the position of maximum value changes.

III. Accelerating expansion and decelerating expansion and the future

What we can see from an analysis in chapter II is that the total gravitational potential energy which decides the acceleration of the universe can have +, 0, - values depending on the density of positive mass and negative mass. This suggests that the universe can show decelerating expansion and accelerating expansion depending on the density difference between positive mass and negative mass.

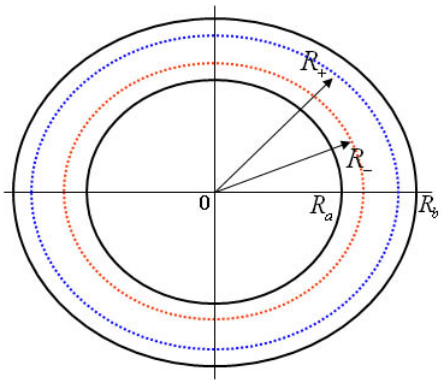

Figure 2: Accelerating expansion and deceleration expansion followed by the density difference between negative mass and positive mass

1.Fundamental settings of pair creation of negative mass and positive mass

1) Suppose equal distribution of positive mass in universal scale throughout the universe. In the same way, suppose equal distribution of negative mass in universal scale throughout the universe. However, negative mass density and positive mass density can be different from each other.

2) Mark positive mass density, negative mass density, positive mass universe radius, negative mass universe radius as ρ_+, ρ_-, R_+, R_-, respectively. Density is in inverse proportion to cubic radius.

3) Set a random three-dimensional sphere with a radius of R. If you suppose that mass distribution has a spherically symmetrical distribution due to general characteristics of gravity, the inner gravity inside R, due to mass distribution outside of this random radius R, is 0. It is Shell Theorem.

4) Therefore, the motion of negative mass and positive mass inside the spherical surface of radius R is decided from gravitational potential between them.

2.Inflation period

1) When negative mass and positive mass conducts pair creation in the early universe, total gravitational potential has a positive value following 1:1 correspondence which is a basic mechanism of pair creation. [1] When it comes to the average density of this negative mass and positive mass at this time, it should consider the possibility of mass difference during pair creation of positive mass and negative mass as mentioned in the preceding paper and formula (57) which shows that the velocity of positive mass is greater than the one of negative mass. [1]

2) Negative mass and positive mass created from Big Bang conducts accelerating expansion, in which case the initial velocity of positive mass is greater than the one of the negative mass, and the density of negative mass is greater than the one of positive mass. Therefore, positive mass accelerated expansion at a faster rate than the negative mass.

3) Gravity is inversely proportional to R_{-+}, which is the average distance between pairs of particle while, in the beginning of Bing Bang such R_{-+} value is a lot less than now and thus the total value of gravitational potential has a large positive value, and further the density is inversely proportional to $1/R^3$, and the density is very high, and so we can see that the total gravitational potential energy has a very large positive value. Therefore, rapid accelerating expansion can be produced, which does not compare with today's accelerated expansion.

If the average distance, r0 is set to Planck length at the beginning of the universe, the density is proportional to $1/R^3$ and potential energy is proportional to 1/R, thus dark energy is in proportion to $1/R^4$. Therefore, the dark energy in the beginning of the universe may increase up to approximately 10^{240} times as compared to today's value. [1]

Therefore, this can give enough energy for accelerating expansion when in inflation.

4) In the inflationary expansion period, by the velocity difference between positive mass and negative mass, the density difference between positive mass and negative mass left in radius R is getting bigger, and if the density difference between negative mass and positive mass turns out larger from the analysis of Chapter II, the total gravitational potential will convert to negative value, at which point inflation will be automatically terminated.

3.Decelerating expansion period

1) If the density difference between positive mass and negative mass goes out of critical range(At a range where the total gravitation potential energy is positive), the total gravitation potential energy converts to negative value as shown in Fig. 1.

2) As the total gravitational energy converts to negative value, the positive mass which conducts accelerating expansion will receive attractive force towards r and it will conduct decelerating expansion, while the negative mass which conducts decelerating expansion will receive attractive force towards r but, the effects appear in the repulsive force, thus accelerating expansion.

3) Accordingly, negative mass density decreases much bigger than positive mass density with the area of radius R, the density difference between the two mass becomes smaller. Therefore it is close to the critical range where gravitational potential energy will have a positive value.

4) If the positive mass and negative mass is in the critical section within radius R, the total gravitational potential will have a positive value again.

4.The current period of accelerating expansion

1) As the total gravitational potential energy converts to positive value, the positive mass which conducts decelerating expansion will receive repulsive force, thus accelerating expansion, while negative mass which conducts

accelerating expansion will receive repulsive force but, the effects are thus decelerating expansion.

2) Accordingly, as the negative mass density decreases smaller than the positive mass density in any area within a radius R, the density difference between the two mass is bigger. This process will continue until the turn of the total gravitational potential sign.

5.An answer to the fine tuning of mass density

This letter explains that, accelerating expansion-decelerating expansion-accelerating expansion in the current universe results from the change of value of the gravitational potential energy according to the variation of the cosmic density of positive mass and negative mass.

In other words, the positive mass density is almost uniformly in the cosmic scale, and the negative mass density is almost uniformly in the cosmic scale, but as positive mass density and negative mass density contained in any radius R in the universe moves in different forms depending on the gravitational potential energy, such density difference can cause any change in deceleration and acceleration of the universe's expansion.

When considering that the radius of the visible universe is less to the size of the whole universe, it can be seen that we are not likely to be located at a unique position where we can observe the changes between negative mass density and positive mass density in all of our universe.

In addition, as the changes in the acceleration occur in the exact opposition to the changed sign of gravitational potential energy of negative mass and positive mass, accelerating expansion and decelerating expansion can be repeated in the form of vibration.

This sign change of gravitational potential energy occurs in the U_T=0, and vibrates on the basis of U_T=0, which provides reasonable explanation to the flatness of the universe, and the fine tuning of mass density which currently, the mass density of the universe will have the near critical value of mass density.

In other words, the fact that the mass density of the universe will have the near critical value to determine acceleration and deceleration comes from the basic assumption that there was a time of pair creation of positive mass and negative mass at the birth of the universe. As the negative mass and positive mass shows opposing forms of motion according to the gravitational potential energy, it is natural that the total gravitational potential energy, U_T is vibrating on the basis of 0. Therefore, we can see that the mass density of the universe will have $U_T = 0$, the near critical value of mass density.

6.The future of the universe

Will it be exponentially accelerating expansion?

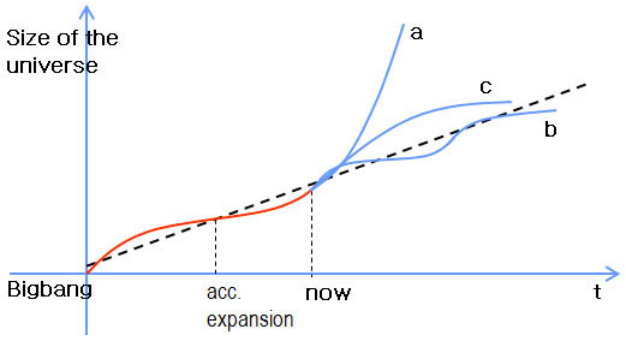

Figure 3: Expansion model of the universe according to the time

1) The standard ΛCDM theory predicts that the dark energy will increase over time, our universe is expanding exponentially, the Big Rip will come. As shown in Fig. 3, a. [2] [3]

2) Some models predict that the universe will stop the accelerating expansion, and after a full big crunch, it will repeat the Big Bang process, which is called Cyclic model. [4]

3) An accurate model should be set up and we should solve field equation. But if we try to guess, the model described in this letter predicts that our universe will repeat the acceleration expansion and decelerating expansion, which is significantly different from Big Rip or Big Crunch Model. As shown in Fig. 3, b.

4) As shown in the earlier paper, [1] the universe's accelerating expansion model means that the average distance, R_{-+} will be growing if the size of the universe will increase, accordingly the size of the dark energy will be reduced. So the accelerating expansion will converge to the critical value. As shown in Fig. 3, c.

IV. Conclusion

The pair creation of negative mass and positive mass is based on a very simple hypothesis, It complies with the laws of conservation of energy, and there was a pair creation of negative mass and positive mass in the early universe, providing answers to many problems of the current universe theory.

This letter explains about accelerating expansion of the early universe, decelerating expansion until about 7 billion years, and accelerating expansion from 7 billion years

ago based on negative mass model, and the changes in the acceleration of the universe only by the gravitational potential energy.

This model explains that density of positive mass and negative mass is almost uniformly throughout the whole universe, but density of positive mass and negative mass included in a random universe radius R can be different from each other.

In addition, as the negative mass and positive mass moves in the different forms depending on the total gravitational potential energy, deceleration and acceleration of the universe depending on the sign of the total gravitational potential energy are likely to be explained.

Furthermore, this model seems to provide a reasonable explanation to the flatness of the universe, and the Fine Tuning of the mass density which mass density of the universe will have a value near the critical mass density as the total gravitational potential energy sign changes in the U_T=0, and the total gravitational potential energy vibrates on the basis of zero.

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