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# Optics in Cosmos: Dark Matter, Negative Matter, GRB, and Some Problems on Light

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**Abstract:** *First, the important contributions of optics for astronomy are reviewed briefly. Next, the negative matter as necessary development of the Dirac negative energy is the simplest dark matter. Its main characteristic is the universal gravitation each other, but is the universal repulsion with all positive matter, so it is invisible. Phantom on dark energy should be a type of negative matter. We research optics of the negative matter, whose basic theory and formulas should be the same only with the negative mass. Thirdly, a process of the infinite gravitational collapse of any supermassive stars must pass through an energy scale of the grand unified theory (GUT), so GRB and some celestial bodies with ultrahigh energy are probably the radiation source of GUT. Finally, we discuss some problems on light: mistake on the local Lorentz transformations of varying speed of light (VSL) theory, developments of laser, and possible transformation among vision and other sensations, etc.*

**Keywords:** *optics, astronomy, dark matter, negative matter, light, GRB, laser, vision.*

## 1. INTRODUCTION

In Yi (Book of Changes) there is that looking up we contemplates the brilliant phenomena of the heavens. This is also old astronomy built by eye. Then using optical telescope Galilei and Newton, et al., developed astronomy, and observed Uranus, Neptune, galaxies and so on. Further, radio telescope, X-ray telescope and gamma-ray telescope, etc., are developed. By various new instruments astronomers observed pulsar, quasar, cosmic background radiation, and gamma-ray bursts (GRB), etc. Modern astronomy has large synoptic survey telescope (LSST), Fermi gamma-ray space telescope, constellation X-ray observatory (Con-X) and advanced radio interferometry between space and earth (ARISE) and so on.

The dark matter as invisible matter and the dark energy are two basic and complex problems remained from 20 century. The dark matter is confirmed by the mass-to-light ratio and the galactic rotation curves, etc [1]. Now investigation of the dark matter and the dark energy is a focus in physics and astronomy [2, 3]. At present in the Universe the dark matter has about 23% and the dark energy has about 73%, only 4% is visible matter [2, 3].

Possibly, this will be analogous with the black radiation and Michelson- Morley experiment derived quantum mechanics and special relativity. Both are all scientific revolution originated from light.

## 2. NEGATIVE MATTER IS THE SIMPLEST DARK MATTER

It is well-known that Dirac predicted anti-particles from his equation and the negative energy state [4]. We proposed the negative matter [5-8], which is developed necessarily from the Dirac negative energy state and Dirac Sea. According to the mass-energy relation in Einstein's relativity, the Dirac's negative energy should correspond to the negative matter, and whose main characteristic is the universal gravitation each other, but is the universal repulsion with all positive matter. Then the anti-particles are only some holes in Dirac Sea. Since positive and negative

matters are repulsive forces, these holes are stable. Such Dirac Sea and its whole theory hold generally for various particles. Otherwise, according to the Pauli Exclusion Principle they hold only for fermions, but cannot be applied to bosons.

We think the anti-(opposite) matter and the negative matter is distinguished exactly. The anti-matter is that some properties of matter are opposite, for instance, charge, baryon number, lepton number, strangeness number and so on, but their masses and total energy are still positive. These particles include positron and various anti-particles. The existence of these particles is already verified. Both positive and opposite matters meet to annihilate to photons with conservation of energy and zero-charge. The negative matter has a negative mass and total energy. Therefore, the creation of negative matter is difficult, but its existence should be stable. In general case both of positive and negative matters are two regions of topological separation by different interactions, so the negative matter is invisible. When the positive and negative matters with the same mass meet, they will become a real vacuum with zero-mass. But, so far their existence in the experiment is not final conclusion. Theoretically, in the negative matter there is also negative anti-matter with opposite charge and so on, but with negative mass [5-9].

The Dirac equations of fermions can describe anti-matter. In the Klein-Gorden equation the $m^2$ term may correspond to ±m, both describe bosons. In the Dirac equations m→-m may also describe the negative matter. A universal relation is:

$$E^2 = m^2c^4 + c^2p^2. \tag{1}$$

It may be generally applied for various positive, opposite and negative matters, and for all ± m, ± E and ± p. Only in the equations described negative matter the mass is negative, while in the equations described opposite matter the charge and so on are opposite. For a relation

$$E^2 = m^2c^4 + c^2(p - \frac{q}{c}A)^2, \text{ i.e., } \quad p - \frac{q}{c}A = \pm\frac{1}{c}\sqrt{E^2 - m^2c^4}, \tag{2}$$

$$\therefore q = (mv \mp \frac{1}{c}\sqrt{E^2 - m^2c^4})\frac{c}{A}. \tag{3}$$

Such the charge may be positive or negative, and is particular distinct for v=0. It corresponds to the opposite matter. Further, both positive and negative energy must exist in the relativistic quantum mechanics [7-9].

The dark matter self does not emit light, and does also not interact with light. The negative matter is repulsive force for photon, and negative-photon with negative energy and negative mass is also repulsive force for general matter, both cannot be observed, and show the dark matter. The state equation of the dark energy is different with the equation of usual matter, and at present assume that it is repulsive force each other. So this may correspond to the negative matter [5-9]. The negative matter is the simplest candidate of dark matter, and can explain some characteristics of the dark matter and dark energy [5-9]. According to the mass-energy relation in Einstein's relativity, the dark matter and dark energy should be unified.

The negative matter as dark matter may form the dark matter rings, for example, for the Psc CL0024+17 cluster galaxies. It can explain many characteristics, for example, the huge lack of mass on dark matter, the repulsive force of dark energy, the negative-dark matter rings round a cluster of galaxies form the repulsive forces and fetter the cluster of galaxies and keep its stability,

and so on. The negative matter determinates the cosmological constant, and is consistent with the conformal gravity theory [10,11], and with the observation of the bullet galaxy cluster [12]. The latter shows obviously a huge dissimilarity between the positive and negative matters. In this case two galaxies collide sharply and meet, but the negative and positive matters are repulsive each other, so the negative matter passes very quickly. Moreover, astronomic observations have shown more dark matter for larger scale. It may explain due to the smaller distance for an early time of the cosmological evolution because of the repulsive force between positive and negative matters.

So far there have many models on dark matter and dark energy. Caldwell proposed phantom as cosmological consequences of a dark energy component with super-negative equation of state, whose cosmic energy density has negative pressure [13]. Then phantom becomes an important dark energy model [13-17]. Hong, et al., considered a higher dimensional gravity theory with a negative kinetic energy phantom field and a cosmological constant [14]. Scherrer and Sen examined phantom dark energy models produced by a field with a negative kinetic term [15]. Chimento, et al., discussed the dark energy density derived from the 3-scalar phantom field, and its negative component plays the role of the negative part of a classical Dirac field [16]. Gonzalez, et al., presented the full nonlinear study of a phantom scalar field accreted into a black hole, which includes that the total energy of the space-time is positive or negative [17]. The total energy is negative, according to classical mechanics or relativity it must be a negative matter. Phantom on dark energy is namely a type of negative matter.

We researched some predictions and possible tests on the negative matter [5-9], and derived the field equations of the repulsive force between the positive and negative matter, and discussed quantitatively the deflected angle of light. We proposed that the mechanism of inflation cosmos [8] due to a huge repulsive force between the positive matter and negative matter created at the same time in quantum fluctuations. It is created from nothing. From this the many worlds and multiverse are formed. The repulsion between the positive and negative matter may form the hyperboloid of two sheets separated for different worlds composed of spherical spaces of positive or negative matter, and may also form the hyperboloid of one sheet, which is a wormhole. Moreover, the Higgs mechanism is possibly a product of positive and negative matter [8]. The existence of four matters on positive, opposite, and negative, negative-opposite particles may form the most perfect symmetrical world [7].

We researched various mathematical representations of negative matter [7]. Its theoretical bases are a basic axiom: the no-contradiction of natural laws, and the two foundational principles: 1). The negative matter obeys the same natural laws of usual matter, including classical, relativistic and quantum physics. 2). There is universal repulsive force between the positive and negative matter. From the bases we discussed the theoretical eight predictions and possible tests, in particular, the season effect [7]. Further, we assume the existence of various complex matter, masses, energies and worlds [8].

## 3. Optics of Negative Matter and Some Basic Formulas

Dirac pointed out: The physical laws are symmetrical between the positive and negative charge [18]. Further, the physical laws should be also symmetrical between the positive and negative matter. We proposed the three basic laws or principles of the negative matter [7]: I. The classical law. The negative matter is repulsive with the positive matter, and obeys the Lorentz transformation and the general Lorentz transformation [19,20], etc. II. The quantum law. For the fermions of the positive and negative matter, and corresponding Dirac equations and so on, both masses are opposite; while for the bosons of the positive and negative matter, and corresponding

the Klein-Gordon equation and so on, both $m^2$ are the same. III. The symmetry (completeness) law. The physical laws are the most perfect symmetries for four matters of positive, opposite, and negative, negative-opposite particles. The existence of four matters will form the most perfect symmetrical world [5-9].

Optics of the negative matter should have the same theory, only its mass is negative. It includes ray optics, wave optics and quantum optics, etc. The eikonal equation

$$\nabla^2\psi + k_0^2 n^2 \psi = 0, \tag{4}$$

And the wave equation

$$\nabla^2\varphi - \frac{n^2}{c^2}\frac{\partial^2\varphi}{\partial t^2} = 0, \tag{5}$$

Correspond to the Klein-Gordon equation

$$(\Box - m^2)\psi = 0. \tag{6}$$

These equations should be the same. Further, some basic formulas are also the same, for example, Maxwell equations, QED, etc. But, Lorentz equation should have the negative mass. Optics of the negative matter should be analogous with modern optics with coherence, nonlinearity and quantum.

In the large-scale space, if there has a negative matter cluster in the positive matter, a part of positive matter will be screened, and another visible matter changes shape by the repulsive lens. Therefore, the visible matter looks much less. The negative matter and their screening positive matter will exhibit the invisible dark matter. According to this hypothesis, since the screening part and distorted part are different, the star-shape observed will be a little different from different positions of the Earth at the solar system. This season effect may be tested [7].

General relativity predicts the gravitational lensing effect [21-23]. Now astronomy has exhibited the gravitational lensing effect of the positive matter [24], for instance, Einstein cross from Q2237+030. From these results the large-scale structure of the Universe may be analyzed [25]. A phenomenon between positive matter and negative matter should be the repulsive lensing. Both will be different in observations.

Wittman, et al., detected weak gravitational lensing distortions of distant galaxies by cosmic dark matter at large scales [26]. Freeman discussed the hunt for dark matter in galaxies [27]. Inada, et al., researched a gravitationally lensed quasar with quadruple images separated by 14.62 arcseconds [28]. Bennett searched astrophysical observations for lensing and eclipsing Einstein's theories [29]. Even some results are perhaps the repulsive lensing.

Ye and Lin introduced the vacuum graded refractive index as a simple optical analysis of gravitational lensing [30,31]. The potential between the positive matter and the negative matter is:

$$V_r = \frac{GM}{r}. \tag{7}$$

According Ye-Lin method, the vacuum graded refractive index will be:

$$n = \exp[-\frac{2V_r}{c^2}] = \exp[-\frac{2GM}{rc^2}]. \quad (8)$$

Scientists proposed two different concepts: dark matter and dark energy, whose reason is both different exhibitions. Dark matter seems to have mass and may become huge conglomeration. Cosmologists compute that the gravitational conglomeration of these dark matters is a key function for the process formed galaxies from general matter. But dark energy seems to be zero mass, and distributes uniformly in the whole space, and its interactions are repulsive. First theoretical model described dark energy is the modified general relativity, which introduces the cosmological constant [32], which can explain many effects of dark energy, but cannot explain dark matter. The cosmological constant may assort the density $\Omega_0 \approx 0.2$ determined by cosmological tests and results predicted by the inflation theory. The inflation theory satisfies a relation $\Omega_0 = 1 - (\Lambda / 3H_0^2)$. When both is equal, so $\Lambda = 2.5 \times 10^{-35} h^2 s^{-2}$ [1]. It is consistent with observational results.

The cosmological constant $\Lambda$ describes possibly the negative matter, which corresponds to the $\Lambda$ term in the gravitational field equation. The field equations of general relativity on the negative matter are [7, 8]:

$$G_{\mu\nu} = 8\pi k(T_{\mu\nu} - T'_{\mu\nu}), \quad (9)$$

$$\text{i.e., } G_{\mu\nu} + 8\pi k T'_{\mu\nu} = 8\pi k T_{\mu\nu} = G_{\mu\nu} + \Lambda g_{\mu\nu}. \quad (10)$$

So $\Lambda$ corresponds to the negative matter, and

$$\Lambda = 8\pi k T'_{\mu\nu} / g_{\mu\nu} = [\rho' + (p'/c^2)](u_\mu u_\nu / g_{\mu\nu}) - p'. \quad (11)$$

On the other hand, the gravitational field equation with the cosmological constant is extended to:

$$G_{\mu\nu} = 8\pi k T_{\mu\nu} \Rightarrow 8\pi k(T_{\mu\nu} + \Lambda g_{\mu\nu}). \quad (12)$$

Here $\Lambda g_{\mu\nu}$ corresponds to the negative energy state and vacuum energy, i.e., Dirac sea.

## 4. GUT OF GRAVITATIONAL COLLAPSE AND GRB

For the negative matter there should also have the corresponding black hole, whose radius is:

$$r = -2Gm/c^2. \quad (13)$$

Black hole is a process of the infinite gravitational collapse of any supermassive stars. But, the process should pass through an energy scale of the grand unified theory (GUT). Therefore, we proposed a gravitational collapsing theory of GUT [33, 34]. It should possess following characteristics: 1). Emission photons and neutrinos, etc., with ultrahigh energy, because

$$\pi^0 \to \gamma\gamma, E(\gamma) = (140/2)\,MeV = 70\,MeV, \quad (14)$$

$$\gamma\gamma \to e^+e^- \to \text{Any hadrons},\ \ e^+e^- \to \gamma\gamma \to \mu^+\mu^- \ldots\ldots \tag{15}$$

2). Ultrahigh energy sources, and disappearance of stars with 100% or near 100%. These processes (14) and (15) are going on again, then the photon energies decrease continually, and nearly all mass of this body may transform into energy. 3). High-speed electrons and photons may produce large redshifts, caused either by a local explosion, or from powerful gravitational fields within the objects themselves [35]. Then photon energy decreases, $E(\gamma) = 14 MeV$ for a redshift z=4. 4). the $\pi^0 \to \gamma\gamma$ produce two symmetric gamma-ray sources, which like "two engines model". Other decays of nucleons will also form some particular directions of emitted energies. 5). The powerhouse is a small object. 6). Rapid motion is associated with the production of energy. These rays should connect with some notable puzzles with ultrahigh energy, for example, GRB as so far the biggest energy luminary are probably the radiation source of GUT [33,34]. Some energy-sources of quasars convert mass of quasars into kinetic energy, with nearly 100% efficiency [35]. A mechanism for the conversion is gravitational collapse [36], but the calculations of such high efficiency are very difficult [37]. The models of quasars include colliding stars, quasar superstars, giant pulsars and black hole theory, etc. All other possible theories will be evolved to the black hole model. At present, the most theory is quasars as some light nuclei of remote active galaxies. A unified model for all active galaxies nuclei (AGN) is the black hole-accretion disk-jet model. The rotational energy of black hole provides a power source of quasars. This process may also correspond to some sources of ultrahigh energy cosmic rays.

Moreover, this theory may compare with the white hole [38], which was first suggested in 1964 by I.Novikov and M.Hjellming as a possible source of quasar energy. White hole is a time-reversed black hole, but it is a mathematical creature [39]. The process of infinite gravitational collapse possesses some properties of white holes, in which baryon-number is nonconservation. Perhaps, this is a true white hole [33,34]. The infinite gravitational collapses pass through the energy scale of GUT. In this case, the matter is released continually from supermassive stars, which is similar to little Universe on big bang. Such both are symmetric.

## 5. SOME PROBLEMS ON LIGHT

Magueijo, et al., discussed the varying speed of light (VSL) theory. It is applied to interpretation of horizon, flatness and cosmological constant problems. As a possible development of general relativity, it is very meaning. Unfortunately the foundations of such theory are far from solid. In particular, Magueijo obtained the local Lorentz transformations in the new units are [40]:

$$d\hat{t}' = \gamma(d\hat{t} - \frac{\hat{v}}{\hat{c}^2} d\hat{x}), d\hat{x}' = \gamma(d\hat{x} - \hat{v}d\hat{t}), \tag{16}$$

Here $$\gamma = \frac{1}{\sqrt{1-(\hat{v}/\hat{c})^2}}. \tag{17}$$

Their forms are the same with usual Lorentz transformations replaced only $c \to \hat{c}$. We proved that the local Lorentz transformations for different systems cannot derive varying speed of light [20].

In the $\hat{x}_1 - \hat{x}_0$ plane, the local Lorentz transformations between inertial systems may become:

$$d\hat{x}_\mu' = \alpha_{\mu\nu} d\hat{x}_\nu, \alpha_{\mu\nu} = \frac{1}{\sqrt{1-\beta^2}} \begin{pmatrix} 1 & -\beta \\ -\beta & 1 \end{pmatrix}. \tag{18}$$

Assume that $\hat{c}$ and $\hat{c}$' are different in the two inertial systems K and K'. For $d\hat{x} - d\hat{t}$ system, the transformation factor is

$$\alpha_{\mu\nu} = \gamma \begin{pmatrix} 1 & -\beta\hat{c} \\ -\beta/\hat{c} & 1 \end{pmatrix}. \tag{19}$$

For $d\hat{x}'-d\hat{t}'$ system

$$\alpha_{\mu\nu}' = \gamma' \begin{pmatrix} 1 & -\beta'\hat{c}' \\ -\beta'/\hat{c}' & 1 \end{pmatrix}. \tag{20}$$

We may introduce another K'' system whose transformation factor should be

$$\alpha_{\mu\nu}'' = \alpha_{\mu\nu}\alpha_{\mu\nu}' = \gamma\gamma' \begin{pmatrix} 1+\beta\hat{c}\beta'/\hat{c}' & -\beta\hat{c}-\beta'\hat{c}' \\ -\beta/\hat{c}-\beta'/\hat{c}' & 1+\beta\beta'\hat{c}'/\hat{c} \end{pmatrix}. \tag{21}$$

The form of the factor $\alpha_{\mu\nu}''$ must be the same with $\alpha_{\mu\nu}$, so $\alpha_{11}'' = \alpha_{00}''$, i.e., $1+\beta\hat{c}\beta'/\hat{c}' = 1+\beta\beta'\hat{c}'/\hat{c}, \therefore |\hat{c}| = |\hat{c}'|$. Therefore, the transformations derive necessarily that the speed $\hat{c}$ is invariant. Correspondingly, in flat space-time with metric $\eta_{\mu\nu}$=diag (-1, 1, 1, 1), $ds^2 = d\hat{x}_i^2 - \hat{c}^2 d\hat{t}^2$ is invariant, and there are the Lorentz transformations with $\hat{c}$=constant. We cannot derive $c = \frac{c_0}{1+(c_0 t/R)}$. In this case, it is not clear and arouses suspicion that $\hat{c}$ may be varying and $\varepsilon$ can be any function [40]. This error is primary. Of course, if the local Lorentz transformations cannot be applied for different systems, they will be also meaningless.

Further, based on the special relativity principle, an invariant speed $c_h$ is necessarily obtained. Therefore, the exact basic principles of the special relativity should be redefined as: I. The special relativity principle, which derives necessarily an invariant speed $c_h$. II. Suppose that the invariant speed $c_h$ in the theory is the speed of light in the vacuum *c*. If the second principle does not hold, for example, the superluminal motions exist; the theory will be still the extensive special relativity, in which the formulations are the same, only c is replaced by the invariant speed $c \rightarrow c_h$. Based on the basic principles of the special relativity, the Lorentz transformation (LT) with smaller velocity v<c and the general Lorentz transformation (GLT) with larger velocity $\bar{v}$ >c are derived

simultaneously by the classification of the timelike and the spacelike intervals. In deriving LT, an additional independent hypothesis has been used, thus the values of velocity are restricted absolutely, and the spacelike interval is excluded. LT and GLT are connected by the de Broglie relation $v\bar{v} = c^2$. From this various superluminal transformations are discussed. We think that LT is unsuitable for photon and neutrino, the photon transformation (PT) is unified for space $x' = r + ct$ and time $t' = t + (r/c)$. It may reasonably overcome some existing difficulties, and cannot restrict that the rest mass of photon and neutrino must be zero. LT, GLT and PT together form a complete structure of the Lorentz group [19, 20]. The quantum entangled state possesses some characters, for example, coherency, nonlocality, quantum teleportation and superluminal, we proposed that it is a new fifth interaction, and may probably apply GLT [20]. If the invariant speed $c_h$ are various invariant velocities, the diversity of space-time will correspond too many worlds.

## 6. DISCUSSION

Laser is very important in modern optics. It emits the coherence wave of light. This already carves out various wave-length lasers. Bose-Einstein condense (BEC) forms atom laser [41], which emits the coherence matter wave, and may be described by a macroscopic wave function. Further, it may develop the boson laser, and even the fermion laser in which pair fermions formed through BCS mechanism.

Usual different sensation systems are independent each other. Our collective open out the potential of blind children, and found through a period training of time, some children by touch or nose or ear can distinguish different colors, even simple figure and numbers. From this and other research, we proposed a hypothesis: The neural excitable cell is continuously induced and excited, then grow out new synapse and dendrite, and the feeling system, hearing system, smell system, etc., may joint to visual system, and form a new neural network, and achieve finally a transformation among vision and other sensations. Further, we proposed some possible tests, for example, for trained mammal, etc., and research possible theories [42]. It is possibly related with the sonoluminescence and biophotonics [43], and is a testable application of the nonlinear whole neurobiology [44,45]. If this hypothesis is approved, it will be a development of science, and benefit to society and humankind. It not only may explain some strange phenomena in Buddhism, Christianity and some religions, and may build a bridge between modern science, traditional culture and religion [42].

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