Philosophy of Modern Astronomy: Negative Matter, Inflation and Black Hole, etc

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Abstract
Astronomy is an important aspect in philosophy of science. First, we proposed the negative matter as unified dark matter and dark energy. Second, the origin of universe and inflation are searched. The negative matter may be the mechanism of inflation. Third, we research gravitational wave and its some new characters. Fourth, entropy decrease in astronomy and black hole are discussed. Finally, the extensive quantum theory and some phenomena in astronomy are investigated.

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1. Introduction

Astronomy is always very important aspect in philosophy of science. First great scientific revolution began in Copernicus (1473-1543). His heliocentric theory changed the world view and cosmological view of mankind. Great philosopher I. Kant (1724-1804) in *The Critique of practical reason* (1788) said: "Two things fill the mind with ever new and increasing admiration and awe, the more often and steadily we reflect upon them: the starry heavens above me and the moral law within me". He researched the nebula theory of astrophysical evolution.

Fang and Zhou searched concepts of space and time in ancient China and in modern cosmology [1]. Anderl researched the philosophical aspects and questions of modern astronomy and astrophysics [2]. The epistemology of astrophysics is strongly based on the use of models and simulations and a complex treatment of large amounts of data.

Cosmology is a science due to both theoretical and observational developments, and is widely regarded as a branch of philosophy [3]. Huby and Clarke discussed cosmology and infinity, and quantum theory and cosmology [4, 5]. RaynerEllisabc researched the philosophy of cosmology, starting off by emphasizing the uniqueness of the universe and the way models are used in description and explanation, final commenting on the scope of enquiry of cosmological theory and the limits of science in relation to the creation of the universe [6]. In this paper we research the negative matter as unified dark matter and dark energy, and may be the mechanism of inflation. We discuss gravitational wave, entropy decrease in astronomy and black hole, and the extensive quantum theory in modern astronomy.

2. Negative Matter Unified Dark Matter and Dark Energy

Dark matter and dark energy as basic focus in astronomy, astrophysics, cosmology and total physics form a great wave in world science. But, the tests of some known models on dark matter and dark energy are very difficult. New data are dark energy 68.3%, dark matter 26.8%, and ordinary matter 4.9% [7].

In 1954 Einstein proposed, one cannot understand why the gravitational masses all have the same sign. Based on Dirac negative energy, and combined Einstein mass-energy relation and principle of equivalence (inertial mass and gravitational mass are equal always), since 2007 we proposed and gradually completed the negative matter as the simplest model of unified dark matter and dark energy. All theories are known, only mass includes positive and negative. Because there is repulsion between positive matter and negative matter, both form two different regions of topological separation, so it is invisible dark matter, and repulsion as dark energy [8-13]. For negative mass Bondi proposed three kinds of mass, and there are four cases. It is a fallacy with contradictions. We study carefully some proofs of the positive mass (energy) theorem, and found that these proof processes all have certain premises. The anti-(opposite) matter and the negative matter are distinguished exactly. It may explain many phenomena of dark matter and dark energy.

The first formula of the negative matter on Newton gravity is

$$F = -\frac{G}{r^2}M_1M_2. \quad (1)$$

Its main characteristic of the negative matter is the universal gravitation each other, but is the universal repulsion with all positive matter. So positive matter and negative matter form two different regions of topological separation, it is invisible dark matter, and repulsion as dark energy. It agrees on Occam's Razor, and may explain many phenomena of dark matter and dark energy. Negative matter is likely to be the cold dark matter with low velocity.

We derived that the rotational velocity of galaxy is approximate constant. Assume that dark matter is completely the negative matter, so we calculated an evolutional ratio between total matter and usual matter from 1 to present 11.82 or 7.88. The mechanism of inflation is origin of positive-negative matters created from nothing, whose expansion is exponential due to strong interactions at small microscopic scales. The negative matter as a candidate of dark matter and dark energy is not only the simplest, and is calculable and testable [8, 11]. Further, we published a book [13].

This model has main conclusions: 1. Almost all theories are known, only mass includes positive and negative. This includes classical mechanics, relativity and quantum physics. The formula of the negative matter on general relativity is

$$G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = 8\pi k(T_{\mu\nu} - T'_{\mu\nu}). \quad (2)$$

Here the cosmological constant Λ corresponds to the negative matter $\Lambda = 8\pi kT'_{\mu\nu}/g_{\mu\nu}$. 2. Based on the formula of total energy, we may calculate simply and derive that the rotational velocity of galaxy is approximate constant, and an evolutional ratio between total matter and usual matter from 1 to present 11.82 or 7.88. We calculate the accelerated expansion at 9.760 billion years. 3. This may explain the mechanism of inflation as origin of positive-negative matters created from nothing, whose expansion is exponential due to strong interactions at small microscopic scales. 4. Based on the repulsive lensing of the negative matter, we may obtain quantitatively some possible ways on observe negative-dark matter in the Milky Way, and other cases. Three types on the dark areas in whole universe (massive black holes, negligible mass nebulae and negative-dark matter) are different. Many observatories should be able to observe these results.

3. Origin of Universe and Inflation

The origin of the universe has always been the focus of attention in astronomy and philosophy. Now the standard model of cosmology [14] is Big-bang, and new inflation [15] and chaotic inflation [16]. Chaos is related to the nonlinear astronomy [17].

Modern astronomy shows that nonlinear interactions and binary stars are very common. Based on the basic equations of a rotating disk on the nebula, we applied the qualitative analysis theory of nonlinear equation, and obtained a nonlinear dynamical model of formation of binary stars [18]. Further, based on the hydrodynamics and hydromagnetics of nebula, from Alfver equation of the cosmical electrodynamics [19] we discussed the formation of binary stars by the qualitative analysis theory [20]. The base of the most exact evolutionary theory of large-scale structures is general relativity, we calculated 2+1 dimensional plane equations of gravitational field, and discussed the evolutions of disk nebula by the qualitative analysis theory, in which binary stars or single star are formed for different conditions. This is the most exact model of formation of binary stars [21].

Based on the Lorenz model derived from the equations of hydrodynamics of nebula, we discussed the formation of binary stars by the qualitative analysis theory of nonlinear equation. Here the two wings in the Lorenz model form just the binary stars. The nonlinear interaction plays a crucial role, and is necessary condition of the formation of binary stars and of multiple stars [18, 20, 21].

Dark matter and dark energy as two basic problems of modern science are very important in philosophy. Based on Dirac's negative energy, we propose the negative matter, which may be the simplest model of unified dark matter and dark energy [8-13]. This is a testable and calculable model, and is the mechanism of inflation as origin of Universe on positive-negative matters created from nothing.

4. Gravitational Wave

It is known that astronomy is continually developed from visual to telescope, from visible light to radio, X-light and full electromagnetic wave observational instruments.

Gravitational wave had been predicted by Einstein in 1918 and the orbital decay of the Hulse-Taylor pulsar (PSR 1913+16) has provided indirect confirmation of the existence of gravitational wave. Recently, gravitational wave forms a focus of scientific development. First, LIGO and Virgo observed gravitational waves from a binary black hole (BBH) merger [22, 23]. From this Rainer Weiss, Barry C. Barish and Kip S. Thorne wined the 2017 Nobel Prize in Physics. We forecast that further investigations may discover difference between gravitational wave and electromagnetic wave [24]. In 2017 LIGO and Virgo observed gravitational waves from a binary neutron star (BNS) inspiral. In GW170817, about 100 seconds before the neutron stars merged they were separated by about 400 kilometers, but completed about 12 orbits every second [25]. Twelve hours later, multiple telescopes detected a new astronomic object (kilonova) in the galaxy NGC 4993, located approximately 130 million light-years from Earth.

In 1996 we predicted two characters of the gravitational wave

[26]: it is nonlinear wave based on the nonlinear equations of general relativity; its velocity is straight propagation, and slightly greater than the speed of light, which deflects at least in the strong gravitational field.

We calculate gravitational redshift and the deflection of light for BNS, delay time is 0.1792s [24]. It is about 1/10 of observed delay time 1.7s. The gravitational wave and electromagnetic wave pass through the luminosity distance about 40 megaparsecs (about 130 million lightyears) and many gravitational redshifts and deflections, it is possible that both differences increase 10 times.

On May 21 2019, LIGO and Virgo observed again a short duration gravitational-wave signal, GW190521, which is the merger of two black holes with masses of about 85 and 66 M⊙, and the remnant mass about 142 M⊙ [27]. Palmese, *et al*., demonstrate GW190521 that can be explained as the merger of central black holes from two ultradwarf galaxies [28].

Gravitational wave astronomy is the new astronomy, and will open a new window on the universe for humanity. Since light cannot be emitted inside black hole, gravitational waves will be the only probe of gravitational changes within the black hole horizon. Further, gravitational waves can provide some correlated information on gravitational changes within various celestial objects.

5. Entropy Decrease and Black Hole

We proposed possible entropy decrease due to fluctuation magnified and internal interactions in isolated systems [29-35], and researched its meaning of philosophy [36], and applied to astronomy, such as in the evolution [37, 38].

Present research on black hole entropy is based on some similarities and the belief of the second law of thermodynamics. Essentially, the area increase theorem is only a necessary evolutional direction of back hole, and is independent of thermodynamics and statistics. Black hole cannot be an isolated system, which is usually a unilateral open system only input but no-output. Thermodynamics of black hole should be the theory of dissipation structure, whose entropy decreases possibly. Moreover, black hole is opposite process to gas diffusion with entropy increase, in which entropy should decrease and it is the biggest internal interaction. Further, this is impossible that both contrary collection and evaporation of black hole are all entropy increase. For opposite black hole and white hole, one is entropy increase, so another must be entropy decrease [38].

When a black hole first forms, the properties of the emitted radiation as measured by observers near future null infinity are very close to the 1974 prediction of Hawking. After an evaporation time, the corrections are large. This effect is a quantum gravitational effect, whose origin is the spreading of the wave function of the black hole's center-of-mass location caused by the kicks of the individual outgoing quanta, discovered by Page in 1980. Eanna, *et al*., argued that this change unlocks the Hawking-Perry-Strominger mechanism for purifying the Hawking radiation [39]. Isi, *et al*., presented observational confirmation of Hawking's black-hole area theorem based on data from GW150914, finding agreement with the prediction with 97% (95%) probability when this model the ringdown including (excluding) overtones of the quadrupolar mode. They obtained this result from a new time-domain analysis of the pre- and postmerger data, and confirm that the inspiral and ringdown portions of the signal are consistent with the same remnant mass and spin, in agreement with general relativity [40]. The metric of a spacetime can be greatly simplified if the spacetime is circular. Xie, *et al*., proved that in generic effective theories of gravity, the spacetime of a stationary, axisymmetric, and asymptotically flat solution must be circular if the solution can be obtained perturbatively from a solution in the general relativity limit. This result applies to a broad class of gravitational theories that include arbitrary scalars and vectors in their light sector, so long as their nonstandard kinetic terms and nonmininal couplings to gravity are treated perturbatively [41].

Based on some astrophysical simulation models, they shown the universe evolves from disorder nebula to structures, which correspond to entropy decrease, and the simulation must be an isolated system only using internal gravitational interactions [42].

6. Quantum Astronomy

In 20 century the two greatest recognized scientific theories are relativity and quantum theory. But they have some big contradictions such as the uncertainty principle and the constancy light speed, from which we proposed the uncertainty relations of general velocity and of the velocity of light [43]. Further, we researched the microscopic relativity and the macroscopic quantum theory [44]. In a word, both unifications are very important development, but it must modify and develop relativity and quantum theory.

Great physicist Feynman pointed out: "There are certain situations in which the peculiarities of quantum mechanics can come out in a special way on large scale." In a special situation "quantum mechanics will produce its own characteristic effects on a large or 'macroscopic' scale" [45].

The Titius-Bode (TB) law describes approximately the average distances between the Sun and various planets in the solar system. The law has implied a quantized phenomenon in the solar system. We developed the TB law to a new form [46, 47]:

$$r_n = an^2, \tag{3}$$

where a is a constant and n is integer. All planets are divided into two groups: the terrestrial and Jovian planets. Let a=0.042 (astronomical unit) for the former, a=1.2 for the latter, so n are continuous natural numbers, and obtained results agree with distances of planets [47]. Both planets with different constants show that their formations passed through different evolutionary processes [48], and is similar to the Shmidt formula $r_n = (a+bn)^2$ [49], which has also introduced different a and b for the terrestrial and Jovian planets.

Because of the similarity between the solar system and the Bohr model, both are respectively based on long-range gravitational field and electric field between nuclei and electrons, we can obtain the quantum constants $H = (aGM_{\odot})^{1/2}$ of the solar system and derive the astronomical Schrodinger equation:

$$iH\frac{\partial \psi}{\partial t} = -\frac{1}{2}H^2\nabla^2\psi + (U-Q)\psi, \tag{4}$$

where Q is a quantum potential in the astronomy. Some exoplanets and ten satellite galaxies of Galaxy, etc. agree with the same form. Further, we proposed the extensive quantum theory. Its mathematical base is fractal. Using the geometric average method, three different values of the quantum constants of man, cell and macromolecule may be derived for biological, chemical and physical discrete systems with different scales. For man, the space size is *2.8136m*, which is about the height of a mankind house. Matthews proved that the maximum height of man is about *3m* by a similar Press theory. The mass is *57.678kg*, which is about human weight. This not only corresponds to the anthropic principle [50], but also is exact.

Moreover, we researched superconductivity, superfluidity, Bose-Einstein condensation (BEC), and various macroscopic quantum phenomena by this theory. We searched the extensive quantum biology and its application in DNA, and the extensive quantum theory in social sciences, in which the social entangled states and exclusion is discussed [51].

The particle astrophysics is a new developing direction of astronomy [52]. The infinite gravitational collapse of any supermassive stars should pass through an energy scale of the grand unified theory (GUT). After nucleon-decays, the supermassive star will convert nearly all its mass into energy, and produce the radiation of GUT. It may probably explain some ultrahigh energy puzzles in astrophysics, for example, gamma-ray bursts (GRB), etc. This is similar with a process of the Big-bang cosmology with a time-reversal evolution in much smaller space scale and mass scale [37]. It may overcome the singularity of black hole and Big-bang cosmology, and in this point the quantum fluctuation exists necessarily [37].

Einstein said: “the most incomprehensible thing about the Universe is that it is comprehensible”. This is the mystery of nature and the universe, and is also the greatness and fascination of science.

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