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SOME INDIRECT PROOF ABOUT THE RELATION BETWEEN UNIVERSAL GRAVITATION AND TEMPERATURE

Xuefeng Wang

School of Management
Harbin Institute of Technology
No. 92, West Dazhi Street, Nangang District, Harbin 150001, P. R. China
wangxuefeng1125@126.com

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Abstract. *Newton's law of universal gravitation is one of the well-known laws of mechanics. In the laws of gravitation, the two most important points are the general applicability of the gravitation constant and that the gravitation force between substances is inversely proportional to the square of the distance. According to the modern gravitation theory, the gravitation force between substances is decided by the mass of substances and the distance, having no relation to their composition and physical state. This paper puts forward a hypothesis that the universal gravitation between substances has relation to their temperature, and holds that the higher the temperature is, the greater the gravitation constant is, and that the gravitational field around substances may disappear when their temperature drops to the minimum temperature. Both the phenomenon of abnormal gravitation and the fact of cosmic expansion found in Astor-observation support the hypothesis that universal gravitation has relation to the temperature of substances. Under this hypothesis, this paper proves that the cosmic expansion caused by the drop of the temperature of substances in the center of gravitation definitely conforms to Hubble's law. Under the hypothesis that the gravitational field of sun weakens, this paper figures out that the change of all planets' orbit radiuses conforms to Hubble's law well. This paper also verifies the reasonability of the hypothesis proposed from the aspects of the measurement experiment of the gravitation constant and the result of Astor-observation and the difficulties that the hypothesis of dark matter and dark energy encounters.*

Keywords: Gravitation, Gravitation constant, Ultrahigh temperature, Cosmic expansion, Dark matter, Dark energy

1. Introduction.

The law of universal gravitation between substances is:

$$F = G\frac{M_1 M_2}{r^2}$$

Here M_1 and M_2 are the mass of two mass points respectively, r is the distance between the two mass points, G is the gravitation constant and F is the gravitation force between the two mass points. The law of universal gravitation and its mathematical formula are found by Newton, but more than 100 years later, the experimental measurement of the gravitation constant G is put forward. Cavendish first obtains the experiment measurement result of the gravitation constant G. The gravitation theory is the compelling field in physics all the time, because it is closely related to the evolution law of celestial bodies. According to Newton's law of universal gravitation, for a mass point, only if substances share the same mass, the gravitational fields they generate in their surrounding space are the same, no matter how different the chemical substances they consist of are, no matter what state they are in (solids, liquids or gases) and no matter what their temperature is.

Up to now, all gravitation theories regard G as the cosmic constant and G has no relation to the composition, structure and temperature of substances. Although there is no enough experimental data to support this viewpoint, it seems to have self-evident truthfulness. In fact, it has become the common sense in physics that G is the cosmic constant. The author of this paper thinks that it is questionable that G is the cosmic constant. It can be seen from the measurement process of G that experimental physicists use solid or liquid substances to measure G at room temperature. There are no experimental results about the gravitation constant G at thousands of degree centigrade or even higher temperature, or at the temperature very close to absolute zero. It may be a blind extrapolation to take the gravitation constant measured at room temperature as the cosmic constant applying to any situation. In the history of physics, it once made many mistakes to extrapolate the mechanical motion laws of macroscopic substances to the kinematics field and dynamics field of microscopic substances which quantum mechanics applies to. Analogously, it also made many mistakes to blindly extrapolate the law of dynamics of the low-velocity motion (classical Newton's laws of motion) to the high-velocity motion which relativistic mechanics applies to. All these mistakes result from the blind extrapolation of existing theories in physics.

The domain where the law of universal gravitation applies most is astrophysics. In the observable universe, some celestial bodies have ultrahigh temperature, such as supernovae, fixed stars and the central zone of some large galaxies, while some celestial bodies have ultralow temperature, such as planets far away from all the blazing stars, meteorites dispersed in space and interstellar dust. The law of universal gravitation using G as a constant is not as reliable as imagined, because the universal gravitation between substances may have relation to their temperature. The above analysis indicates that it is not a trouble-making sophistry to question whether G is the cosmic constant, but an important problem in physics which needs verifying through experiments. Whether the gravitation constant will change with the change of substances' temperature can only be demonstrated through well-designed experiments. It is impossible to draw the correct conclusion only through logical reasoning, and it is not reliable that to extrapolate the experimental results obtained at room temperature to the situation of ultrahigh temperature and ultralow temperature only based on intuition and blind extrapolation.

In Section 2, the hypothesis that the universal gravitation between substances has relation to their temperature is proposed and gives reasons for it. We account for the rationality of the proposed hypothesis by analyzing several observed results in astrophysics. In Section 3, the mathematical formula that gravitation constant and orbital radius satisfy is deduced by the use of calculus when the gravitation constant G changes, and the mathematical formula obtained is consistent with Hubble's law. In Section 4, a simulating computation is made for the changes of the radiuses of planets' orbits using the data of all celestial bodies in solar system when the gravitational intensity of the sun decreases slowly, and the conclusion shows that the velocity of recession of a planet is proportional to the distance between the sun and the planet. In Section 5, several phenomena which will appear are discussed through logical reasoning when the universal gravitation between substances has relation to their temperature, and we also point out that there may be great deviation between some estimates of parameter (such as total mass, average density and density distribution) of many celestial bodies that astrophysicists provide and the actual values. The experimental measurement of the gravitation constant at different temperatures especially for the ultrahigh temperature is discussed with the help of observed data of celestial bodies. The last part is the conclusion.

2. **Hypothesis about the Universal Gravitation and the Astrophysical Observations.** This paper proposes the hypothesis that the universal gravitation between substances has relation to their temperature, which includes the following three aspects.

(1) The gravitation force between two mass points is decided by Newton's law of universal gravitation, so there are:

$$F_{12} = G(T_1)\frac{m_1 m_2}{r^2}, \quad F_{21} = G(T_2)\frac{m_1 m_2}{r^2}$$

Differing from the classical Newton's law of universal gravitation, F_{12} is the gravitation force that m_1 acts on m_2, T_1 is the temperature of the substance m_1, $G(T_1)$ is the gravitation constant of the gravitational field that the substance m_1 generates, and $G(T_1)$ is a function of T_1. F_{21} is the gravitation force that m_2 acts on m_1, T_2 is the temperature of the substance m_2, $G(T_2)$ is the gravitation constant of the gravitational field that the substance m_2 generates, and $G(T_2)$ is a function of T_2.

(2) G is an increasing function of substances' temperature, the higher the temperature is, the greater the gravitation constant G is. At present, the gravitation constant G ($G = 6.671 \times 10^{-11}\text{N}\cdot\text{m}^2/\text{s}^2$) only applies to substances with room temperature, while the gravitation constant G of substances with ultrahigh temperature may be dozens of or more times the value with room temperature.

(3) Theoretically, there exist substances at the minimum temperature, and in this situation the substances do not generate gravitational field around their space. Its inertial mass is invariant and subjected to the gravitational field of other substances.

An important reason for the hypothesis that the universal gravitation between substances has relation to their temperature is that there are no experimental results for the gravitation constant G about ultrahigh-temperature substances or ultralow-temperature substances. According to modern theories in physics, the gravitation constant G is the universal constant in the universe. However, the author of this paper thinks that such an inference is questionable, because there are no experimental results support it. In a certain range of temperature, there should be no insurmountable technical obstacles for experimental physicists to conduct experiments to verify whether the gravitation between substances has relation to their temperature. It is relatively easy to conduct experiments at low temperature, but difficult to conduct experiments at high temperature, because high-temperature substances need to remain liquid for ease of experiments.

If the mechanism of the universal gravitation between substances is that the motion of fundamental particles in substances generates gravitational field by disturbing the special substance in vacuum, physicists called the special substance ether over one hundred years ago and field now, then it is a rational inference that the higher the temperature of substances is, the stronger the disturbance is, and it is inevitably a logical conclusion that the higher the temperature of substances is, the stronger the gravitation between substances is. On the other hand, if the temperature of substances drops to the minimum level so that the motion of fundamental particles in the substances stops, the substances stop disturbing the special substance in vacuum. Under this condition, the substances with mass will not generate gravitational field in vacuum around their space. This logic reasoning is only a kind of speculation because there is little knowledge about the physical properties of the vacuum. It is only a visualized analogy to take the vacuum as some particular fluid, and the function of such an analogy is to keep reasoned thinking from interrupting by the nothingness of the vacuum. Certainly, such an inference cannot be the scientific proof about the proposed hypothesis, but it is a meaningful inspiration. The above description and explanation are also the thought origin of the hypothesis proposed in this paper. If the gravitation constant G does have relation to the temperature of substance, we may use "gravitation coefficient" to express G. In order to be consistent with the habit, we also use gravitation constant to express G in this paper.

Suppose that the temperature of substances in the central zones of some galaxies is ultrahigh. According to the hypothesis proposed in this paper, if the mass of the substances in the central zones of some galaxies is estimated accurately, it will be found that the real gravitational field intensity around these galaxies is larger than the theoretical one, because ultrahigh-temperature substances will generate stronger gravitational field. From another perspective, if the distribution of the gravitational field intensity around these galaxies is estimated accurately by means of the observation and computation of the rotational motion of galaxies, and the total mass of the substances in the central zones of galaxies is estimated by the use of Newton's law of gravitation on this base, it will be found that the estimated total mass is too large because the gravitation constant used during the calculation is too small.

With the help of the observations of the motions for some galaxies in the universe, it has been found that the situation which does not conform to Newton's law of gravitation is comparatively common. Astrophysicists are able to accurately measure the angular velocity of celestial bodies rotating around the galaxies, they can also measure accurately the distance between the center of a galaxy and celestial bodies, so that they can calculate the motion acceleration of celestial bodies and the gravitation force that the center of the galaxy acts on celestial bodies. In addition, astrophysicists can accurately estimate the total mass of the substances in the central zone of a galaxy, so that they can estimate the gravitational field intensity that the substances in the central zone of a galaxy generate based on Newton's law of gravitation. Astrophysicists have founded that there is a difference of nearly 10 times between the gravitational field intensities estimated by the use of the two methods in many galaxies. Observations show that the substances in the central zone of a galaxy cannot provide enough gravitation to keep the observed galaxy motion in many galaxies, so that some additional gravitation must exist. Therefore, dark matter is proposed, and these dark matters have complete permeability to electromagnetic waves, massless and being able to provide additional gravitation. So far, the experimental observation of dark matter has failed to acquire convincing results. That is, theories and experimental studies on dark matter encounter great difficulties. In this paper, we think that the additional gravitation is provided by the ultrahigh-temperature substances in the central zones of galaxies and that dark matter may not exist.

For many galaxies, the substances in the central zones of galaxies are of ultrahigh temperature and radiate energy ceaselessly, and their temperature decreases slowly. According to the hypothesis proposed in this paper, as their temperature drops, the gravitational field produced by the substances in the central zones of galaxies will weaken continuously. Therefore, galaxies in the state of expansion will accelerate their expansion, the ones in the stable state will start expanding and the ones in the state of shrinkage will decelerate their shrinkage velocity. The orbit radius of the celestial bodies motioning in the approximately circular orbit will increase with the dropping of the temperature of the substances in the central zones of galaxies. Celestial bodies in these galaxies will get far away from each other, which are the situation the cosmic expansion describes. The cosmic expansion is based on the observed results of the systemic spectrum redshift of celestial bodies, and these observed results are undoubtedly the reflection of the most significant properties of the universe. To explain cosmic expansion, some physicists think that there exists a kind of dark energy widely distributed in the universe, these dark energy has complete permeability to electromagnetic waves and is unable to be detected by the observation of electromagnetic radiation, and these dark energy is the source of the power leading to cosmic expansion. In this paper, we think that the accelerated expansion of the universe results from the weakening of the gravitation which is caused by the dropping of the temperature of substances in the universe, and that dark energy may not exist.

3. **Mathematic Analysis of Celestial Bodies in a Circular System.** Assume that one galaxy is in the stable state of rotating around its center in an approximate circular motion, M_2 denotes the total mass of the substances in the center of the galaxy, M_1 denotes some celestial body rotating around its center in an approximate circular motion, r is the orbit radius of M_1, V is the velocity of M_1, and G is the gravitation constant. According to the conditions of the circular orbit, the gravitational force F acting on M_1 is equal to the product of its mass and acceleration, that is $F = M_1 \frac{V^2(r)}{r}$. Therefore, there is:

$$\frac{M_1 V^2(r)}{r} = G\frac{M_1 M_2}{r^2} \tag{1}$$

Suppose that the temperature of the substances in the galaxy's center drops uniformly, so that the gravitation constant of the gravitational field around their space also decreases uniformly. In the process of G uniformly and slowly decreasing to $G - \Delta G$, the orbit radius of M_1 increases from r to $r + \Delta r$. Assume that the change of G is uniform and slow. In the interval of $r \le x \le r + \Delta r$, approximately $G(x) = G - \frac{\Delta G}{\Delta r}(x - r)$. The work the celestial body M_1 has done against the gravitational force of M_2 is denoted by ΔW, so there is:

$$\begin{aligned}\Delta W &= \int_r^{r+\Delta r} G(x)\frac{M_1 M_2}{x^2}dx = \int_r^{r+\Delta r} \left(G - \frac{\Delta G}{\Delta r}(x - r)\right)\frac{M_1 M_2}{x^2}dx \\ &= \left(G + \frac{\Delta G}{\Delta r}r\right)\frac{M_1 M_2 \Delta r}{r\,(r + \Delta r)} - \frac{\Delta G}{\Delta r}M_1 M_2 \ln\frac{r + \Delta r}{r}\end{aligned} \tag{2}$$

According to the law of conservation of energy, the potential energy of M_1 increases by ΔW, so the kinetic energy of M_1 decreases by ΔW. There is:

$$\begin{aligned}\Delta W &= \frac{1}{2}M_1 V^2(r) - \frac{1}{2}M_1 V^2(r + \Delta r) \\ &= \left(G + \frac{\Delta G}{\Delta r}r\right)\frac{M_1 M_2 \Delta r}{r\,(r + \Delta r)} - \frac{\Delta G}{\Delta r}M_1 M_2 \ln\frac{r + \Delta r}{r}\end{aligned} \tag{3}$$

Because the gravitation constant G changes slowly enough, the celestial body M_1 should move on the circular orbit whose radius is $r + \Delta r$ after the gravitation constant G stops changing. According to the conditions of the circular orbit, there is:

$$\frac{M_1 V^2(r + \Delta r)}{r + \Delta r} = (G - \Delta G)\frac{M_1 M_2}{(r + \Delta r)^2} \tag{4}$$

$V^2(r + \Delta r)$ can be solved according to expression (4). $V^2(r)$ can be solved according to expression (1). They can be substituted into expression (3), and it can be obtained that:

$$\frac{(r + \Delta r)G}{r} - 2\left(G + \frac{\Delta G}{\Delta r}r\right)\frac{\Delta r}{r} + 2\frac{\Delta G}{\Delta r}(r + \Delta r)\ln\left(\frac{r + \Delta r}{r}\right) = G - \Delta G \tag{5}$$

When $\frac{\Delta r}{r}$ is very small, we can obtain $\ln\left(\frac{r+\Delta r}{r}\right) \approx \frac{\Delta r}{r}$. After expression (5) is rearranged, it can be acquired that:

$$\frac{\Delta r}{r} \approx \frac{\Delta G/G}{1 - 2(\Delta G/G)} \tag{6}$$

In the evolution process of celestial bodies, the change of the gravitation constant G must be very slow, which inevitably enables $\frac{\Delta r}{r}$ extremely close to 0. Therefore, the precision is extremely high that Formula (6) satisfies. For different orbit radiuses r, Δr

are the increments of the orbit radiuses of celestial bodies in the same time interval, and obviously Δr is proportional to the velocity of celestial bodies getting away from the center of the galaxy. Δr and ΔG are the same in sign, which show that the cosmic expansion corresponds to the decreasing of the gravitation constant. Formula (6) shows that if the gravitational field generated by the substances in the center of the galaxy weakens slowly, the ratio of the velocity of a celestial body getting away from the center of the galaxy to its orbit radius r is a constant, or the velocity of a celestial body getting away from the center of the galaxy is proportional to its orbit radius r. Formula (6) is consistent with Hubble's law (about the cosmic expansion), which also accounts for the rationality of the hypothesis that the universal gravitation between substances has relation to their temperature.

Mathematic analysis of celestial bodies in elliptical orbit in the case of the change of the gravitation constant can get similar results, but the derivation process and expressions are more complicated and the changes of pericenter and apocenter need taking into account. Corresponding formulas will not be listed here.

4. **The Simulating Computation in Solar System When the Gravitation Decreases Slowly.** In order to further explain the relation between cosmic expansion and the decrement of the gravitation, this paper assumes that the gravitation force of the sun begins to decrease from some moment. According to the orbiting data of planets in solar system, the changes of orbit radiuses of all planets are calculated by the use of Newton's laws. It is difficult to deduce a simple equation of motion when the gravitation constant G changes over time, so the motion trail of an object under given condition in the gravitational field is solved through the numerical differentiation.

The position of the planet A at the moment t is denoted by $\mathbf{r}(t) = (x(t), y(t))$. The origin $(0, 0)$ is the center where there is a mass point whose mass is M_2, and the gravitation field is generated by M_2, and $G(t)$ denotes the function of the gravitation constant that changes over time. According to Newton's law of universal gravitation and Newton's second law, the motion trail $\mathbf{r}(t) = (x(t), y(t))$ of the planet A satisfies the following second-order differential equation:

$$\begin{cases} x''(t) = -G(t) \cdot \dfrac{M_2}{(x^2(t) + y^2(t))^{3/2}} \cdot x(t) \\ y''(t) = -G(t) \cdot \dfrac{M_2}{(x^2(t) + y^2(t))^{3/2}} \cdot y(t) \end{cases} \tag{7}$$

M_2 is the mass of the sun, that is $M_2 = 1.99 \times 10^{30}$kg. G is the known gravitation constant, that is $G = 6.671 \times 10^{-11}\text{N}\cdot\text{m}^2/\text{s}^2$. The assumed situation is examined where the gravitation constant of the sun decreases by 5% slowly from G in a year.

Take the motion of the earth revolving around the sun for example. Its orbit radius is 1.49×10^{11}m and its linear velocity is 29.6×10^3m/s. The initial conditions are chosen as follows:

$$\begin{cases} (x(0), y(0)) = (1.49 \times 10^{11}, 0) \\ (x'(0), y'(0)) = (0, 29.6 \times 10^3) \end{cases}$$

For a common second-order differential equation:

$$y'' = f(t, y)$$

The iterative formula by discretization is:

$$y_{k+1} = 2y_k - y_{k-1} + (\Delta t)^2 f(t_k, y_k)$$

It is denoted that $x_k = x(k \cdot \Delta t)$, $y_k = y(k \cdot \Delta t)$, $G_k = G(k \cdot \Delta t)$. For a sufficiently small Δt, the following iterative formula is derived from the above expression:

$$\begin{cases} x_{k+1} = 2x_k - x_{k-1} + (\Delta t)^2 \left(\frac{-G_k M_2}{(x_k^2+y_k^2)^{3/2}} \right) x_k \\ y_{k+1} = 2y_k - y_{k-1} + (\Delta t)^2 \left(\frac{-G_k M_2}{(x_k^2+y_k^2)^{3/2}} \right) y_k \end{cases} \tag{8}$$

According to the position and velocity of the earth at some moment, with a proper Δt, (x_0, y_0) and (x_1, y_1) can be determined, and (x_2, y_2), (x_3, y_3), $\dots$, (x_n, y_n) can also be calculated according to the iterative Formula (8), so that the orbit of the earth after a number of years can be calculated.

The basic data and the computed results of the changes of orbit radiuses of all planets in solar system are listed in Table 1.

Table 1. The computational results of the increment of orbit radiuses of planets resulting from the slow decrement of the gravitation constant of the sun

Planets	Period (s)	Velocity (m/s)	Orbit radius (m)	Orbit radius after the gravitation constant decreases (m)	Increment of the orbit radius (m)	Incremental percentage (%)
Mercury	7.60×10^6	47.9×10^3	0.58×10^{11}	0.612×10^{11}	0.032×10^{11}	5.5
Venus	1.94×10^7	34.9×10^3	1.08×10^{11}	1.138×10^{11}	0.058×10^{11}	5.4
Earth	3.16×10^7	29.6×10^3	1.49×10^{11}	1.57×10^{11}	0.08×10^{11}	5.4
Mars	5.94×10^7	24.0×10^3	2.27×10^{11}	2.39×10^{11}	0.12×10^{11}	5.3
Jupiter	3.74×10^8	13.0×10^3	7.75×10^{11}	8.155×10^{11}	0.405×10^{11}	5.2
Saturn	9.30×10^8	9.6×10^3	1.42×10^{12}	1.498×10^{12}	0.078×10^{12}	5.5
Uranus	2.66×10^9	6.8×10^3	2.86×10^{12}	3.015×10^{12}	0.155×10^{12}	5.4
Neptune	5.20×10^9	5.4×10^3	4.48×10^{12}	4.72×10^{12}	0.24×10^{12}	5.4
Pluto	7.82×10^9	4.7×10^3	5.90×10^{12}	6.214×10^{12}	0.314×10^{12}	5.3

According to Table 1, if the gravitation constant G of the sun decreases by 5% during some time interval, then the orbit radiuses of all planets in solar system will increase by an average of 5.4% and this percentage will be very steady. According to Formula (6) we can obtain $\frac{\Delta r}{r} = 5.55\%$, we can see that the computational results in Table 1 conform to the theoretical Formula (6). The results show that, if the gravitation constant of the sun decreases continuously, the situation that planets get away from the sun continuously will inevitably appear and the velocity of recession of planets is proportional to the distance between plants and the sun in solar system.

5. **The Verification and Several Inferences about the Hypothesis.** Assume that the intensity of the gravitational field generated by substances is an increasing function of their temperature, and we also assume that substances in the central zone of galaxies are in ultrahigh temperature which continuously drops over time. From the qualitative perspective, both abnormal gravitation and accelerating expansion of the universe observed in galaxies are the natural corollaries of the hypothesis proposed in this paper, while the hypotheses of dark matter and dark energy are needless. Certainly, if the temperature of substances in the central zone of some galaxy increases continuously, then the gravitation

force will strengthen, and galaxies in the stable state will start shrinking and the ones in the state of shrinkage will accelerate their shrinkage velocity. Galaxies in the state of shrinkage have been discovered by astronomers, which shows that not all corners of the universe are expanding, and that the theory of cosmic expansion cannot make a convincing explanation of local shrinkage of the universe, while the hypothesis that the universal gravitation between substances has relation to their temperature can make a reasonable explanation.

Physicists have successfully estimated the mass of the earth, the mass of the sun, the average density of the earth, the density of substances in the central zone of the earth, the average density of the sun and the average density and total mass of substances in the central zones of many galaxies by the use of Newton's law of universal gravitation. These estimations are all obtained based on the fact that the gravitation constant G is an unchanged universal constant. If it is verified by experiment that G increases with the temperature of substances rising, then all these estimations need to be remade, because the temperature in the central zone of the earth is approximately 6,000°C and that in the central zone of the sun is about 20,000,000°C, and these temperatures are much higher than room temperature. Qualitative conclusions should be as follows: the density of substances in the central zone of the earth will be less than present estimated value and the average density of the sun is less than the present estimated value; the total mass of the sun will be much less than the present estimated value and the total mass of the earth is slightly less than the estimated value; once the temperature of the sun drops greatly, the nine planets will recede to the orbits farther from the sun.

For the hypothesis that universal gravitation between substances has relation to their temperature, it is also necessary to note that a direct corollary of this hypothesis is that the universal gravitation between substances is not always symmetrical. If the temperature of substance 1 has a large difference with that of substance 2, then the gravitation force that substance 1 acts on substance 2 is not equal to that substance 2 acts on substance 1. This corollary is astonishing. If it is proved correct, universal gravitation between substances does not have perfect symmetry. This lack of perfect symmetry must be closely related to the distribution and evolution law of substances in the universe.

The precise measurement of the intensity of the gravitational field around ultrahigh-temperature and ultralow-temperature substances is an experiment of decisive meaning. The technology of measuring micro forces precisely has already been mastered by experimental physicists. In the measurement of the gravitation constant of high-temperature substances, two key technologies are needed: one is the heating technology and the other is the technology of keeping substances liquid. Although gaseous substances can achieve very high temperature, their densities are too low to measure the universal gravitation precisely. It is necessary to use high temperature resistant and high pressure resistant materials to keep high-temperature substances liquid. There should be no technical difficulties in keeping the temperature of liquid substances with 3,000°C, while there will be great difficulties in keeping the temperature of liquid substances with 100,000°C. It should be easy to conduct experiments at low temperature, and the low temperature of $10^{-6}K$ has already been achieved easily. Once that the universal gravitation between substances has relation to their temperature is proved by experiments, there are many problems to continue to discuss for theoretical physicists, experimental physicists and astrophysics.

If that the gravitation constant increases with the temperature of substances rising is verified by experiments, these experimental results will be of great significance in physics, even if it is proved only at not too high temperature (for example, 3000°C) and the change of the gravitation constant of substances is slight (for instance, G increases by 1%) compared with that at room temperature. The measurement experiment of G at ultrahigh temperature may not be conducted in the lab environment on the earth, but the value of G can be calculated reasonably based on astrophysical observations. If the total mass of substances in the central zone of the galaxy S_i is estimated correctly and the alleged dark matter does not exist, then the intensity of the gravitational field around the galaxy can be estimated correctly based on its rotational speed and geometric dimensioning and thereby the gravitation constant G_i can be estimated correctly. In addition, the temperature T_i of substances in the central zone of the galaxy can be estimated correctly through the spectrum analysis technology, so that the corresponding value of G_i at T_i can be obtained. After sufficient experimental data and estimated data (G_i, T_i), $i = 1, 2, \ldots, n$ are acquired, if T_i are uniformly distributed in the range from room temperature to ultrahigh temperature, the empirical curve $G(T)$ can be gained.

6. **Conclusion.** This paper puts forward the hypothesis that the universal gravitation between substances is connected with their temperature, and holds that the higher the temperature is, the stronger the gravitational field is. Astronomical observations are analyzed qualitatively, the hypothesis of dark matter and dark energy is examined, the situation that the radiuses of the circular orbit of celestial bodies change over the change of gravitation constant is analyzed mathematically, and a simulating computation is made for the change law of planets' orbits by use of the data of the celestial bodies in solar system when we assume the gravitation constant changes. These analyses, reasoning and deduced mathematical formulas show that the hypothesis proposed in this paper has the strong explanatory ability in astronomical observations. Both the deduced mathematical formulas and the simulating computation results conform to Hubble's law, which also accounts for the rationality of the hypothesis proposed in this paper. Certainly, it all depends on the precise measurements of the gravitation constants of ultrahigh-temperature and ultralow-temperature substances.

This study is carried out based on generally accepted theories in physics, but the question brought forward in this paper is significant, fire-new and uncared-for. The theories and experimental facts quoted in this paper are all of great acquaintance to physicists, and the references should be those physics literature generally accepted by them, so the author believes that it is not necessary to list a series of references for this paper.

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