Motions of Observable Structures Ruled by Hierarchical Two-body Gravitation in the Universe

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In the past, various scenarios have been presented to account for the formation of the solar system and our galaxy, but ever-increasing observations prove these conceptions to be incomplete. Here we propose, all objects in the universe are organized in an orderly series of hierarchical two-body systems with gravitation. Within these systems, the two components of each two-body system are orbiting around the barycenter of this system, and at the same time each two-body system is orbiting around the barycenter of a superior two-body system. Based on this hierarchical two-body association, an approximate uniform velocity feature for all stars in a galaxy, and galaxies in a cluster, is determined. Under the effect of gravitation, a successive hierarchical orbital shrinkage results in high redshifts of distant galaxies and planar (disc) rotational profile of large-scale structures like the solar system and galaxy.

"… if redshift are not primarily due to velocity shift … the velocity-distance relation is linear, the distribution of the nebula is uniform, there is no evidence of expansion, no trace of curvature, no restriction of the time scale … and we find ourselves in the presence of one of the principles of nature that is still unknown to us today … whereas, if redshifts are velocity shifts which measure the rate of expansion, the expanding models are definitely inconsistent with the observations that have been made … expanding models are a forced interpretation of the observational results"

-- *E. Hubble* [1]

1. Introduction

For the last 260 years a number of models had been proposed by cosmologists to describe the formation of the solar system. These models include the Protoplanet Theory, the Modern Laplacian Model, the Capture Theory, the Accretion Theory, and the Solar Nebula Disk Model that is currently widely-accepted. Woolfson in 1992 reviewed their successes and failures [2]. So far, the Solar Nebula Disk Model is still surrounded by a series of unresolved problems such as the loss of angular momentum, the disappearance of the disk, the formation of planetesimals, the formation of giant planets and their migration, and so on [3-7]. The earlier conceptions of galaxies were derived from Wright [8] and Kant [9]. The later theories of galaxy formation include top-down models that think proto-galaxies form in a large-scale simultaneous collapse lasting about one hundred million years [10], and bottom-up models that think small structures such as globular clusters form first, and then a number of such bodies accrete to form a larger galaxy [11]. The current galaxy formation theories focus on larger scale cold dark matter cosmological models [12], and more extensive reviews of this kind of model can be seen in the publications [13-15]. Even so, the detailed process of galaxy formation is still an open question in cosmology. Many observations in 20st century revealed that both stars in the galaxy and galaxies in the clusters revolve much faster than would be expected from Newtonian and Einstein theories [16-20]. This discrepancy is currently thought to betray the presence of dark matter that permeates the galaxy and extends into the galaxy's halo. But no candidate particles so far have been detected to act as this non-baryonic matter, even though ever-increasing searches are being carried out. This thereby inspires one to consider an alternative gravity theory to explain galaxy dynamics. Edwin Hubble's discovery of the redshifts of distant galaxies [21] was thought by other scientists to be a suggestion that the universe is expanding, but the majority of astronomers had forgotten Hubble's words at the beginning of this paper. In this present paper, I would like to propose a model to demonstrate the formation of observable structures and their motions, and further account for galaxy rotation curves and high redshifts of distant galaxies.

2. Proposition

Because of an unknown significant event, small units like ordinary particles became evenly distributed in the universe. And because of the impulse from another unknown form of matter (assumed to be dark matter), ordinary particles obtained a kind of random movement in space. Once two ordinary particles due to random movement approach one another closely enough, gravitation between them captures each other to form a clump. As the distribution of ordinary particles is extensive, countless clumps of particles are created simultaneously. And then the clumps, due to random movement, continue to capture each other to form larger clumps, and eventually a very large lump of particles is created to form a proto-celestial object (Fig. 1). As the distribution of larger clumps is also extensive, many proto-celestial objects are formed simultaneously; and then these proto-celestial objects due to random movement continue to capture each other to form some systems. On a large-scale, these systems, due to random movement, continue to capture each other to form even larger systems (Fig. 2). By this means, all celestial objects were eventually organized in a very gigantic final system. As all objects are fixed together through a pattern of one-capture-one, a series of hierarchical two-body systems are determined

(Fig. 3). Within these systems, the two components of each two-body system are orbiting around the barycenter of this system, and at the same time each two-body system is also orbiting around the barycenter of a superior two-body system.

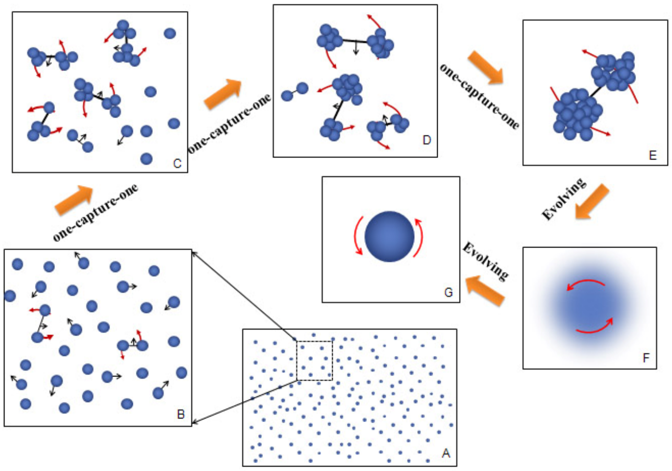

Fig. 1. The building-up of a primordial celestial object from small units (ordinary particles). Some particles are evenly distributed in a scene (A). Due to random movements, they approach and capture each other to form larger lumps through a pattern of one-capture-one (B, C, D, E) until a primordial rotational celestial object is formed (F). The primordial celestial object finally evolves into a mature revolving celestial object (G). Little black arrows in diagram denote the movements of particles and their lumps. Line between two lumps (particles) denotes gravitation. Red arrows in diagram (B, C, D, E) represent the motions of the two components of each two-body system, thereby determining a rotational celestial object.

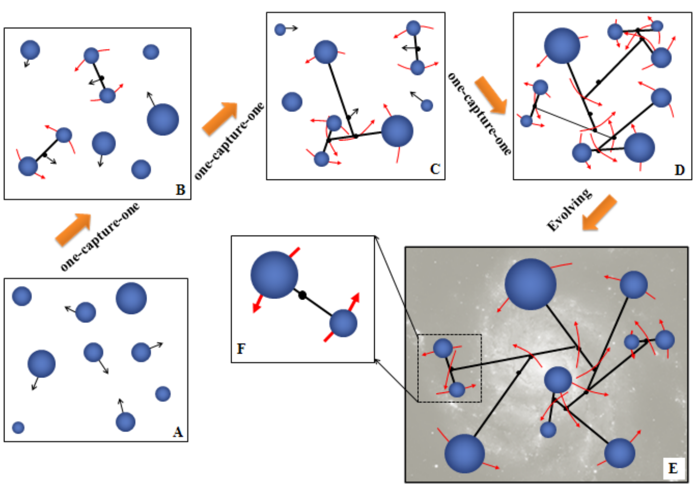

Fig. 2. The building-up of a large system from primordial celestial objects. Some primordial celestial objects are evenly distributed in a scene (A). Due to random movements, they approach and capture each other to form a series of two-body systems until a final association is formed (B, C, D). The association further evolves into a large planar rotational structure (E). Note that background is set by a spiral galaxy (Photo provided courtesy of NASA). The two components of each two-body system are orbiting around the barycenter of this system (F). Little black arrows in diagram denote the random movements of primordial celestial objects and their associations, while red arrows denote the motions of the two-components of each two-body system. Lines between objects denote gravitations. Little black dot represents the barycenter of each two-body system.

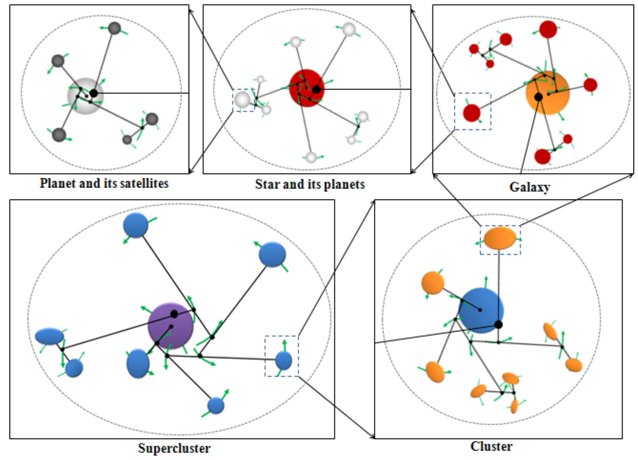

Fig. 3. A model of the association of observable structures and their motions in the universe. Each two-body system is being connected to a superior two-body system with gravitation. Black line denotes gravitation. Green arrows represent the motion of each component, and little black dot represents the barycenter of each two-body system. Dashed circle represents the scope of a hierarchical system, in which large black dot represents its barycenter.

3. Explanation of Astronomical Phenomenon

3.1. Galaxy Rotation Curve

We assume: The stars **a**, **b**, **c**, **d**, **e**, **f**, **g**, and **h** in a sample galaxy form a series of hierarchical two-body systems, in which objects **a** and **b** form the first two-body system, and at the same time the first two-body system and object **c** form the second two-body system, and so on. Ultimately, the sixth two-body system and object **h** form the final two-body system. The masses of these objects are defined as $100m$, $10m$, $20m$, $10m$, $30m$, $10m$, $25m$, and $15m$, respectively, and their distances from the center of galaxy are defined as $0.2r$, $0.4r$, $0.6r$, $0.8r$, $1.0r$, $1.2r$, $1.4r$, and $1.6r$, respectively. To derive the coordinate of each celestial object, we treat the barycenter of a final two-body system as the center of this galaxy, and the center is further used as an origin to set a Cartesian coordinate system (Fig. 4).

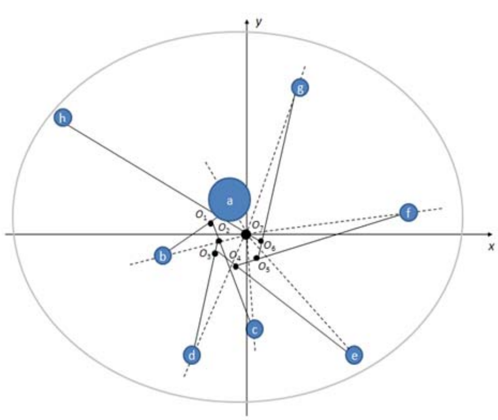

Fig. 4. A Cartesian coordinate system is set for all sample stars in the galaxy. Point O_1, O_2, O_3, O_4, O_5, O_6, and O_7 are the barycenters

of related two-body systems, respectively, and point O_7 is the origin of the system. Black line between the two components of each two-body system represents gravitation. Ellipse denotes the boundary of the galaxy.

We further assume that all stars are located in the same plane and the angles of star **a**, **b**, **c**, **d**, **e**, **f**, **g**, and **h** to the positive *x* axis are 120°, 200°, 280°, 240°, 310°, 25°, 75°, and 150°, respectively. And then the coordinates of these objects may be worked out as follows:

$$
\begin{aligned}
&\mathbf{a}\text{: } x_a = Lo_7a \cdot \cos 120° = -0.10000r \quad y_a = Lo_7a \cdot \sin 120° = +0.17321r \\
&\mathbf{b}\text{: } x_b = Lo_7b \cdot \cos 200° = -0.37588r \quad y_b = Lo_7b \cdot \sin 200° = -0.13681r \\
&\mathbf{c}\text{: } x_c = Lo_7c \cdot \cos 280° = +0.10419r \quad y_c = Lo_7c \cdot \sin 280° = -0.59088r \\
&\mathbf{d}\text{: } x_d = Lo_7d \cdot \cos 240° = -0.40000r \quad y_d = Lo_7d \cdot \sin 240° = -0.69282r \\
&\mathbf{e}\text{: } x_e = Lo_7e \cdot \cos 310° = +0.64279r \quad y_e = Lo_7e \cdot \sin 310° = -0.76604r \\
&\mathbf{f}\text{: } x_f = Lo_7f \cdot \cos 25° = +1.08757r \quad y_f = Lo_7f \cdot \sin 25° = +0.50714r \\
&\mathbf{g}\text{: } x_g = Lo_7g \cdot \cos 75° = +0.36235r \quad y_g = Lo_7g \cdot \sin 75° = +1.35230r \\
&\mathbf{h}\text{: } x_h = Lo_7h \cdot \cos 150° = -1.38564r \quad y_h = Lo_7h \cdot \sin 150° = +0.80000r
\end{aligned}
\tag{1}
$$

where $Lo_7a = 0.2r$, $Lo_7b = 0.4r$, $Lo_7c = 0.6r$, $Lo_7d = 0.8r$, $Lo_7e = 1.0r$, $Lo_7f = 1.2r$, $Lo_7g = 1.4r$, $Lo_7h = 1.6r$.

As the momentums of the two components of each two-body sysytem are conservative, according to the property of algebra and geometry, the coordinates of point O_1, O_2, O_3, O_4, O_5, and O_6 may be worked out as follows:

$$
\begin{aligned}
x_{O6} &= -\ 0.10139r,\ y_{O6} = +\ 0.05850r \\
x_{O5} &= -\ 0.06514r,\ y_{O5} = +\ 0.25450r \\
x_{O4} &= -\ 0.00500r,\ y_{O4} = +\ 0.29930r \\
x_{O3} &= +\ 0.13167r,\ y_{O3} = +\ 0.19930r \\
x_{O2} &= +\ 0.11103r,\ y_{O2} = +\ 0.16130r \\
x_{O1} &= +\ 0.15016r,\ y_{O1} = +\ 0.08320r
\end{aligned}
\tag{2}
$$

In the calculation, as the masses of both star **a** and **b** are given, to maintain a dynamical stablity for the system, the presumed position of star **a** need to be corrected, namely,

$$
\begin{aligned}
x_{a1} &= x_{O1} + \frac{m_b}{m_a}\left(x_{O1} + x_b\right) = +\ 0.12758r \\
y_{a1} &= y_{O1} + \frac{m_b}{m_a}\left(y_{O1} + y_b\right) = +\ 0.07780r \\
L_{O7}a_1 &= 0.14945r
\end{aligned}
\tag{3}
$$

And then the distance between the two components of each two-body system and the orbital radius of each component may be worked out. In each two-body system the motion of each component is determined by the mass of another component and the distance between them, this fits to a dynamical equation

$$
G\frac{M_1 M_1}{r_1^{\,2}} = G\frac{M_2 v_2^{\,2}}{r_2} \tag{4}
$$

(the left hand is the gravitational force undergone by one component from another component, the right hand is the centrifugal force that is due to the motion of this component around a centre position), where M_1 and M_2 respectively represent the mass of the two components of a two-body system, G is the gravitational constant, r_1 represents the distance between the two components, and r_2 represents orbital radius that M_2 revolves around the barycenter of this system. After a simplification, there will be $v_2 = \sqrt{\dfrac{GM_1 r_2}{r_1^{\,2}}}$. It is significant to keep in mind that if another component of this two-body system is composed of a series of subordinate hierarchical two-body systems, the gravitational force undergone by this component should be the summation of the attractions from all components in the subordinate two-body system. For instance, star **e** is one component of the fourth two-body system, and another component of this system is composed of a series of subordinate two-body systems that include star **a**, **b**, **c**, and **d**, thus, the total gravitational force undergone by object **e** in fouth two-body system is the summation of the attractions from object **a**, **b**, **c**, and **d,** namely

$$
\begin{aligned}
F = &\frac{Gm_a m_e}{(L_{ao_1} + L_{o_1o_2} + L_{o_2o_3} + L_{o_3e})^2} + \frac{Gm_b m_e}{(L_{bo_1} + L_{o_1o_2} + L_{o_2o_3} + L_{o_3e})^2} \\
&+ \frac{Gm_c m_e}{(L_{co_2} + L_{o_2o_3} + L_{o_3e})^2} + \frac{Gm_d m_e}{(L_{do_3} + L_{o_3e})^2}
\end{aligned}
\tag{5}
$$

As object **e** is revolving around O_4 and its orbital radius is L_{o_4e}, therefore the centrifugal force aroused by its motion may be written as $m_e v_e^{\,2} / L_{o_4e}$. And then,

$$
v_e = \sqrt{GL_{o_4e}\left[\begin{aligned}
&\frac{m_a}{(L_{ao_1} + L_{o_1o_2} + L_{o_2o_3} + L_{o_3e})^2} \\
&+ \frac{m_b}{(L_{bo_1} + L_{o_1o_2} + L_{o_2o_3} + L_{o_3e})^2} \\
&+ \frac{m_c}{(L_{co_2} + L_{o_2o_3} + L_{o_3e})^2} + \frac{m_d}{(L_{do_3} + L_{o_3e})^2}
\end{aligned}\right]}
\tag{6}
$$

By this method, all parameters are worked out (Table 1). Also note that a corrected distance for star **a** to the center of galaxy is 0.15*r*. According to these parameters, a velocity curve without scale may be yielded (Fig. 5).

Object	R_1	M	F	R_2	V
	(r)	(m)	(Gm^2r^{-2})	(r)	($(Gmr^{-1})^{-1/2}$)
a	0.2(0.15)	100	3338	0.02	0.88
b	0.4	10	3338	0.57	13.80
c	0.6	20	1745	0.75	8.10
d	0.8	10	938	1.04	9.87
e	1	30	2260	1.25	9.69
f	1.2	10	630	1.18	8.62
g	1.4	25	1370	1.37	8.68
h	1.6	15	540	1.60	7.59

Table 1. Parameters of related objects used in the model. Where R_1 denotes the distance of the object to the center of the galaxy; M denotes the mass of each object; F denotes the total gravitation encountered by each object; R_2 denotes orbital radius of each object; V denotes the orbital velocity.

It is clear that, regardless of star **a**, the circular velocities of all other objects generally exhibit a flat profile. From the distance of 0.2*r* to 0.4*r* the velocity rises steeply, but it soon takes place a decrease from 0.4*r* to 0.6*r*. On the whole, the velocity keeps approximately uniform from 0.6*r* to 1.6*r*, which fits to the observed rotation curves of galaxies and clusters. In the simulation the mass of star **a** is given as 100*m*, which accounts for 45.45% the total mass of all sample objects. In addition, the distance of the barycenter of each two-body system to the center of galaxy is less than 0.184*r*, and the distance of star **a** to the center of galaxy after a correction is 0.15*r*. This suggests that, if the radius of star **a** is long enough, the barycenters of all two-body systems may always be located in the body of star **a**. As star **a** has a huge mass and the barycenter of each two-body system is invisible, it is feasible to treat the position of star **a** as the center of that galaxy. Also note that because all sample stars are organized in a series of hierarchical two-body systems, the motion of a superior two-body system necessarily causes the objects in the surbordinate two-body systems to move. This partly moderates the motions of all the stars in the galaxy. The simulation here indicates that, due to the association of a series of hierarchical two-body systems, the motion of a star (galaxy) in the galaxy (cluster) is determined by all the mass that is interior to the region of this star (galaxy), thereby yielding a flat velocity curve for all stars (galaxies) in the galaxy (cluster).

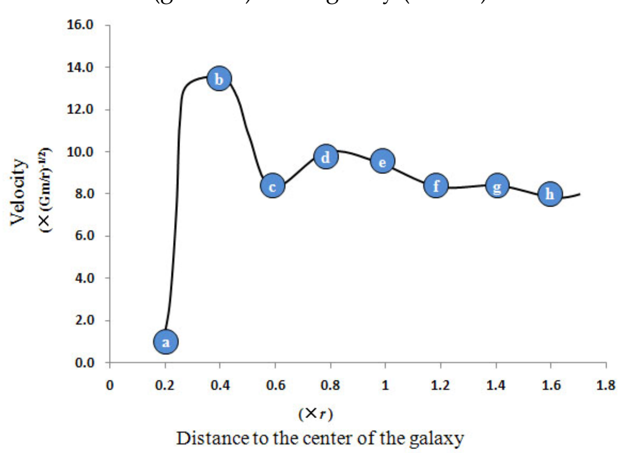

Fig. 5. A modelling galaxy rotation curve based on hierarchical two-body gravitation.

3.2. The Redshifts of Distant Galaxies

The orbital energy of a celestial object is undoubtedly derived from the contribution of gravitation, and the effect of gravitation is to drag objects to approach each other. Therefore the two components of each two-body system under the effect of gravitation are continually approaching closer to each other. As demonstrated previously, stars located in the same galaxy are organized in a series of hierarchical two-body systems, and galaxies located in the same cluster are organized in a series of superior hierarchical two-body systems. This determines that under the effect of gravitation a hierarchical approach between galaxies in the same cluster and between stars in the same galaxy may make the cluster and galaxy shrink simultaneously. The simultaneous approaches between galaxies in the same cluster, and between stars in the same galaxy, mean that the attractions between them are increasing. The increase of attraction further indicates that photons emitted from a galaxy need to consume more energy to reach the Milky Way, and thereby determines their spectral lines to become redshifts. Figure 6 shows the evolution of a two-dimensional local universe. It is assumed that the size of the local universe is *oa* • *ob* and cluster (A, B) and local group are located in the local universe at the same time. It can be found that galaxy (m) is being attracted by other galaxies in cluster (A) through the barycenters of related two-body systems (point 1, 2, 3, etc.). Clearly, with the passage of time, the shrinkage of cluster decreases the attracting distance from other galaxies to galaxy (m), and thereby increases the attraction between them. On the other hand, as a galaxy is composed of mainly stars, the photons from a galaxy are actually derived from the sum of photons that are emitted from all stars. The shrinkage of galaxy therefore decreases the attracting distance from one star to another star, and thereby increases the attraction between them. The increase of attraction between galaxies and between stars means that the later photons emitted from galaxy (m) need to consume more energy to reach the Milky Way than the earlier ones. An accelerative redshift for galaxy (m) is thus determined. In other words, the longer the time continues, the stronger the galaxy (m) receives attraction from other galaxies in cluster (A). This means that the photons emitted from galaxy (m) need to consume more energy to reach the Milky Way, and so the larger the galaxy (m) becomes redshifted as seen from the Milky Way. The situation is the same for all distant galaxies in other clusters. Moreover, due to the shrinkage of the cluster, the galaxies in the near side of the cluster generally look like departing from the Milky Way while the galaxies in the far side generally look like approaching the Milky Way; the Doppler effect for them is respectively redshift and blueshift. However, the majority of galaxies in other clusters are very distant from the Local Group, so the magnitude of blueshift that comes from a Doppler effect is likely to be too small to counteract the redshift that is derived from the shrinkage of both cluster and its galaxies. The accumulated effect is therefore a redshift.

The redshifts is currently thought by cosmologists to be a consequence of spatial expansion. However, this conception appears to be incompatible with observation. It is well known that before the birth of telescope, people's eyes cover just a region that includes the Earth, the Moon, the Sun, and distant stars, of which the universe is composed. After the birth of telescope, a larger universe is opened to the public. Today, our eyes have been extended by many thousands of light years to see beyond distant galaxies. Throughout this period of history, it is safe for us to say that the universe observed is completely beyond the upper limit of field of vision, and it is infinite. The expanding universe means that the universe in the past has a smaller volume than the present, and in the future a larger volume than the present. In other words, this conception confines the universe into a limited space. In addition to this, the expanding universe also means that the expansion is launched from some special position along some certain directions. However, all established observations cannot support such an expansion. From Figure 6 it may see the local universe always keep constant (with a volume of *oa* • *ob*) during a long period of astronomical time, but due to the shrinkages of all clusters and galaxies, the local universe looks like becoming more and more hollow. In this sense, all distant galaxies appear to increasingly depart from us. So far, the evidence that is employed by cosmologists to support an expanding universe is derived from the redshifts of distant galaxies. However, the redshifts may be ascribed to many factors such as light refraction by intermediate dust and gas, and the shrinkage of large-scale structure (cluster and its galaxies) that we propose here, etc. And then we carefully grasp Hubble's warning in 1936, "*if redshift are not primarily due to velocity shift …, there is no evidence of expansion, no trace of curvature, no restriction of the time scale … and we find ourselves in the presence of one of the principles of nature that is still unknown to us today … whereas, if redshifts are velocity shifts which measure the rate of expansion, the expanding models are definitely inconsistent with the observations that have been made … expanding models are a forced interpretation of the observational results*". A simultaneously hierarchical shrinking for all large-scale structures is reasonable enough to account for presently observed redshift, therefore the conception of expanding universe is still premature.

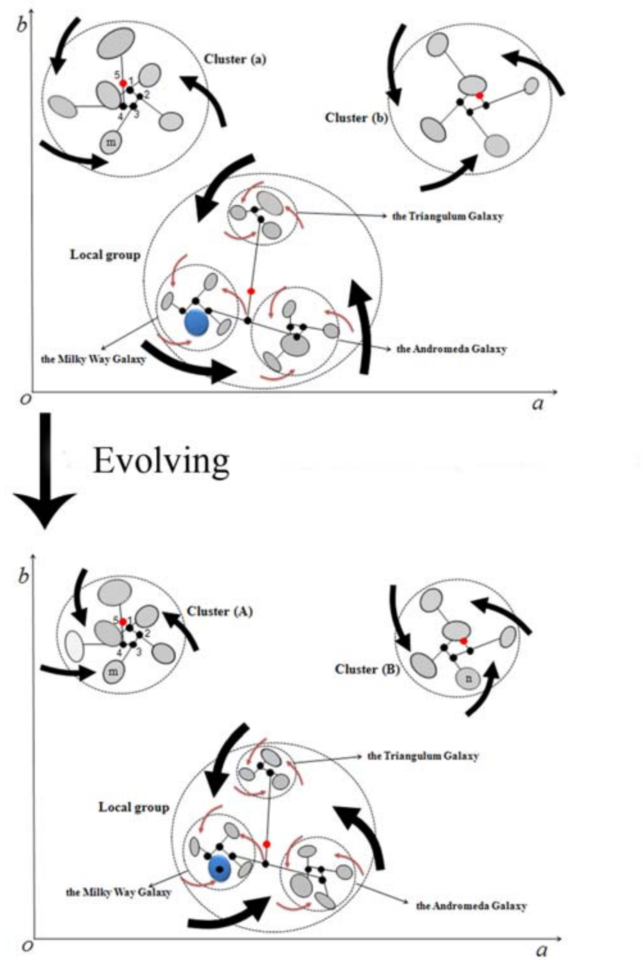

Fig. 6. The evolution of a two-dimensional local universe. The part of local universe involves three sample clusters: Local Group, cluster (A), and cluster (B). Top: the initial distributions of several clusters and their galaxies. Bottom: the final distributions of them after a long period of astronomical time of dynamical evolution. Black dots the barycenters of related two-body systems in the cluster while red dot denotes the barycenter of the cluster. Large black arrow represents the shrinkage of cluster in size, while small red arrow represents the shrinkage of galaxy and its satellites in local group. Blue patch denotes the primary of the Milky Way Galaxy. Large dashed circle represent the boundary of each cluster, while small dashed circle denotes the boundary of both primary galaxy and their satellites.

The redshifts of the galaxies in our Local Group and the nebulae from Hubble's observation fit this expectation (Tab.2). For the 26 satellite galaxies in our Local Group, we find they are gravitationally bound by the Milky Way, and the Andromeda and Triangulum galaxies, respectively. The 12 satellite galaxies of the Milky Way have both redshifts and blueshifts. In contrast, NGC 598 (Triangulum galaxy) and almost all satellite galaxies (excluding Andromeda IV) of Andromeda perform only blueshifts. And for 24 nebulae from Hubble's observation, except for 6 nebulae that reside in our Local Group, nearly all nebulae in other clusters generally display redshifts. As demonstrated previously, the Milky Way and its satellite galaxies form a series of hierarchical two-body systems, which is similar to our solar system. The Milky Way is like the Sun, the satellite galaxies are like the planets. Hence, every satellite galaxy looks as if it is orbiting around the Milky Way, because planets in the movements can repeatedly approach and depart from the Sun, thus the satellite galaxies in their movements can also repeatedly approach and depart from the Milky Way. This determines the coexistence of the redshifts (for departing satellites) and blueshifts (for approaching satellites). At the same time as the Milky Way, the Andromeda and the Triangulum galaxies also form two superior hierarchical two-body systems, and the two components of each two-body system are also approaching each other. Therefore both the Andromeda and Triangulum galaxies are, on the whole, approaching the Milky Way. This causes their satellite galaxies to be blueshifted.

26 galaxies in local group				24 nebulae from Hubble's observation[21]			
Primary galaxy	Satellite	Distance (mly)	Redshift (km s^{-1})	Primary cluster	Object	r	v
The Milky Way	Small Magellanic	1.97	+158	Local group	S.Mag.	0.032	+170
	Large Magellanic	1.57	+278		L.Mag.	0.034	+290
	NGC 6822	1.63	-57		N.G.C.6822	0.214	-130
	Ursa Minor Dwarf	2	-247		598	0.263	-70
	Draco Dwarf	2.6	-292		221	0.275	-185
	Carina Dwarf	3.3	+230		224	0.275	-220
	Sextans Dwarf	2.9	+224	Other cluster	5457	0.45	+200
	Sculptor Dwarf	2.9	+110		4736	0.5	+290
	Fornax Dwarf	4.6	+53		5194	0.5	+270
	Leo I	8.2	+285		4449	0.63	+200
	Leo II	6.9	-87		4214	0.8	+300
	Ursa Major Dwarf	2	-247		3031	0.9	-30
The Triangulum	NGC 598	2.81	-179		3627	0.9	+650
The Andromeda	NGC 221	2.49	-200		4826	0.9	+150

NGC 224	2.52	-301	5236	0.9	+500
NGC 205	2.69	-241	1068	1	+920
NGC 147	2.53	-193	5055	1.1	+450
NGC 185	2.05	-202	7331	1.1	+500
Andromeda I	2.4	-368	4258	1.4	+500
Andromeda II	2.22	-188	4151	1.7	+960
Andromeda III	2.44	-351	4382	2	+500
Andromeda IV	…	+256	4472	2	+850
Andromeda V	2.52	-403	4486	2	+800
Pegasus Dwarf	2.7	-354	4649	2	+1090
Cassiopeia Dwarf	2.58	-307	r = distance in unit of 10^6 parsecs.		
Andromeda IX	2.5	-216	v = measured velocity in km./sec.		

Table 2. Redshift distribution of both the most galaxies of local group and the nebulae from Hubble's observation.

Here we have presented a cause to account for the redshifts of distant galaxies. In contrast, a lot of explanations in the past had been proposed by cosmologists for the redshifts. The explanations are roughly divided by others into three types: 1) a Doppler shift argument whereby the galaxies themselves are moving through static space-time; 2) an Einstein effect which gives redshifts that result from gravitational forces; and 3) an expansion of space-time under the Friedmann equations. However, Misner, Thorne and Wheeler generally expressed a high suspicion for the first and second explanations. They thought that the first has the problem of how galaxies could be accelerated to near the speed of light without disruption, and the second has the problem of how objects with gravitational redshifts greater than z = 0.5 are still stable without collapse. This suspicion relates to both the magnitude of redshifts and the effectiveness of gravitational force. The redshift data is often derived from the calculation of a theoretical formula. This further relates to a problem whether the formula is applicable for the whole universe. If it works only in the local universe, the magnitude of redshifts that are worked out for the objects in the frontiers of the universe will have a high uncertainty. A theoretical formula may often be effective in local region but it may not be valid for every time and everywhere. The suspicion from Misner, Thorne and Wheeler is apparently based on a conception that Newton's mechanics (universal gravitation) is always valid. As we demonstrated in this paper, the gravitation between objects is indirect and hierarchical, which is different from what Newton's universal gravitation states.

A simple example may prove that the suspicion of Misner, Thorne and Wheeler is unnecessary. For instance, if a person at the Earth's surface is accelerated from rest to several tens of km per second or more, he would be torn apart by the force that gives this acceleration. On the other hand, however, the solar system has a speed of more than 200 km per second in orbiting the Milky Way's centre. At this point, the person apparently has the same magnitude of the speed in this movement, even though the person is still at rest at the Earth's surface. Why will the person not be torn apart by the force that runs the motion of the solar system around the Milky Way's centre? As I proposed here, the motions of objects in space are hierarchical, each object at the same time is taking part in countless hierarchical motions, and each of these hierarchical motions is also being run by a gravitational force. As a result, it is unnecessary for us to fear whether the high-speed galaxies will be torn apart by the forces that are responsible for these motions.

In the frame of hierarchical two-body models, the universe is infinite, this means that a local supercluster still belongs to a larger system, and the larger system also belongs to an even larger system, etc. In the even larger system, the person may have a speed of more than hundreds of thousands of km per second, but he may still survive at the Earth's surface. In fact, if we put a person in a galaxy several thousands of light years away to observe us, and if the person believes Newton's universal gravitation, he must be extremely astonished why we with a speed of more several thousands of km per second in space still may leisurely drink coffee together but without any disruption. An Einstein effect and an expansion of space-time are also invalid in the frame of hierarchical two-body models, thus any suspicion based on them is not considered here.

4. Discussion

Historically, two theories had been presented to explain the structure of the universe and the motion of celestial objects. The first one is the geocentric model that believes the Earth is the center of the universe and all objects like the Sun, planets, and distant stars are orbiting around it. The other is the heliocentric model that believes the Sun is the center of the universe and planets are orbiting around it, and distant stars are motionless. Unfortunately, the established observation does not fit to the claim of the heliocentric model.

For a long time it has been known that the Earth and Moon are orbiting around the common center of their masses, and at the same time the Earth-Moon system is orbiting around the center of the solar system, and the solar system is orbiting around the centre of the Milky Way Galaxy. Simultaneously, the Milky Way Galaxy is orbiting around the centre of the Local Group, and the Local Group is orbiting around the centre of a supercluster.

A large number of investigations reveal that most multiple stars are organized in a hierarchical two-body manner. For instance, Alpha Centauri is composed of a main binary yellow dwarf pair (Alpha Centauri A and Alpha Centauri B), and an outlying red dwarf, Proxima Centauri. Both A and B form a physical binary star, and Proxima C and this binary star form a superior two-body system whose orbit is much larger than that of the binary star system [22]. Recent observation confirms that many young multiple stars are organized in trapezia, and the centre of gravity is not fixed at some point but moves as the stars change their mutual positions [23]. It is clear that all the observations trend to fit to a hierarchical two-body model. Figure 7 compares the established two models and the hierarchical two-body model. According to the hierarchical two-body model, the

Sun and planets are organized in an orderly series of hierarchical two-body orbiting systems, and at the same time the solar system and other stars are organized in an orderly series of superior hierarchical two-body orbiting systems. At the same time, the Milky Way Galaxy and other galaxies are also organized in an orderly series of even more superior hierarchical two-body orbiting systems, and the Local Group and other clusters are also organized in an orderly series of gigantic hierarchical two-body systems orbiting each other. As the two components of each two-body system are orbiting around the common center of their mass, the orbit of each two-body system can always nest inside the orbit of a superior two-body system. This arrangement enables all curving movements in space to be well-regulated. It has been found that the solar system is just one of countless stellar systems that make up the Milky Way, and the Local Group that includes the Milky Way is also just one of many clusters that make up Local Supercluster. There is no a special position for the solar system in the universe. Therefore, the hierarchical two-body model is more consistent with the observable universe than the geocentric and heliocentric models.

At present the leading Solar Nebula Disk Model that accounts for the formation of the solar system is still surrounded by a series of unresolved problems such as the loss of angular momentum, the disappearance of the disk, the formation of planetesimals, the formation of giant planets and their migration, and so on [3-7]. In addition to this, there are still two significant problems that discredit the Solar Nebula Disk Model.

First, as we know, some planets (like the four giant planets, Jupiter, Saturn, Uranus, and Neptune) often have a lot of satellites to form a planetary system, and each planetary system has a different inclination to the ecliptic, especially the Uranus's system has a high inclination that is more than 90 degrees. If the solar system was initially formed from the collapse of a primordial nebula, planets and their satellites (planetary systems) should have been pushed to fall on the same plane when the collapse takes place, but the various inclinations of planetary systems do not fit to this expectation.

Second, in the past decades many extrasolar Jovian-mass planets are found to have retrograde orbits with respect to the spin direction of the star. This is different from the situation in the solar system where planets have prograde orbits with respect to the spin of the Sun. If the solar system is formed from the collapse of a primordial nebula, this mechanism should be applicable for the formation of all stellar systems, and therefore the extrasolar Jovian-mass planets should have the orbits like what in the solar system.

Observation also shows that both the solar system and galaxy are generally with planar rotational profile, and that the satellites of Jupiter (Saturn) approximately lie in the same plane. For example, the nearest 23 satellites of the Saturn have inclinations of less than 1.6 degrees, while the nearest 8 satellites of the Jupiter have inclinations of no more than 1.1 degrees [24, 25]. Recent observation reveals that all classical satellites of the Milky Way Galaxy – the eleven brightest dwarf galaxies – lie more or less in the same plane; they are forming some sort of a disc in the sky [26]. This common, planar feature suggests that all large structures should derive from the same physical mechanism.

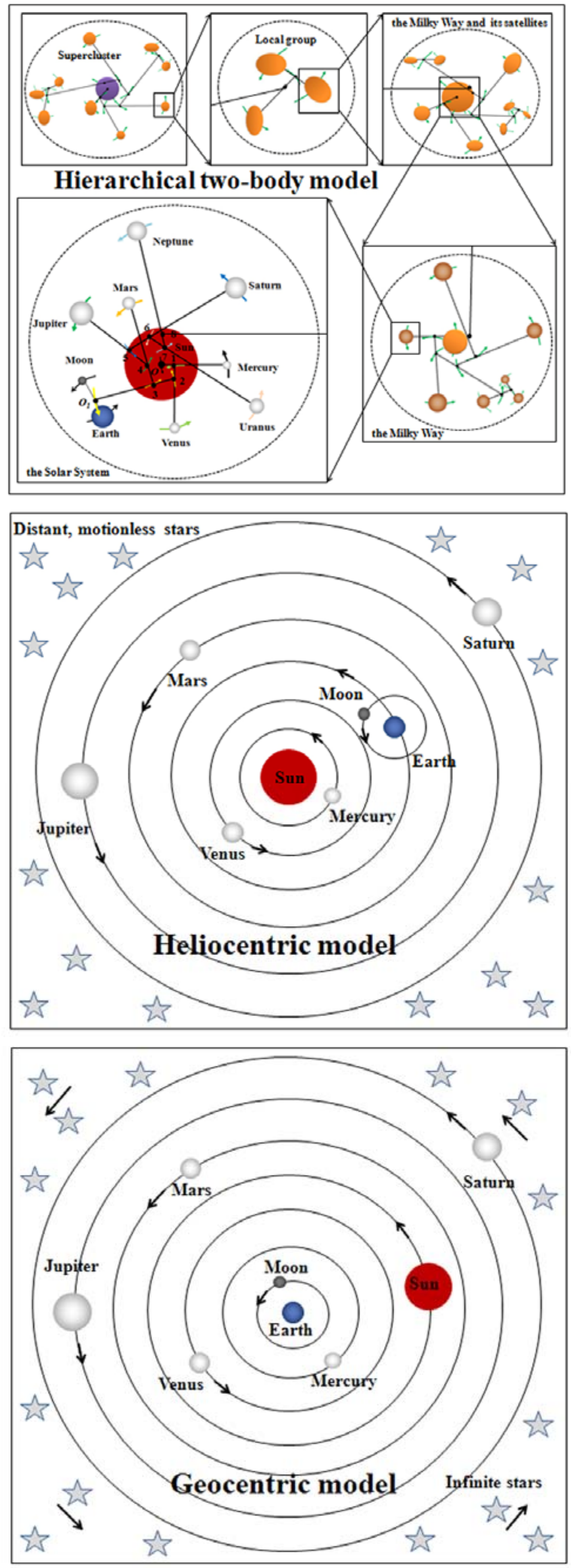

Fig. 7. A comparison of three models that account for the frame of the universe and the motion of celestial object. In the hierarchical two-body model a subordinate two-body system is always connected to a superior two-body system with gravitation. For in-

stance, in the solar system the Sun and the Mercury form first two-body system, and at the same time this two-body system and the Venus form second two-body system, etc., and dot 1, 2, 3, etc. respectively denote the barycenter of related two-body system, while O and O_1 denote the barycenters of both the Sun and Earth-Moon system, respectively. Dashed circle denotes the boundary of each hierarchical system. Colour arrow in the circle denotes the motion of a component. Black dot denotes the barycenter of each two-body system. Black line denotes gravitation.

At this point, I would like to propose a theoretical model to account for the formation of both the stellar system and galaxy: because of a series of dynamical processes, many proto-celestial objects were simultaneously formed in space (as proposed in the Proposition of this paper). Subsequently these celestial objects due to random movement continue to capture each other to form some large systems, in which each system includes a center body and its families. On large scale, these systems due to random movement continue to capture each other to form larger systems, in which each includes a center body and its families. By order, all larger systems due to random movement were automatically organized into a gigantic system that includes a center body and its families. The solar system is just one of countless families that are organized in a series of hierarchical two-body systems. As all celestial objects are captured to fix together through a pattern of one to one, a series of hierarchical two-body systems are naturally determined. As all celestial objects before they are captured have random movements in space, they may thus have different directions to approach each other, this determines various orbital declinations for planets and their moons (the co-existence of prograde and retrograde orbits, for instance), and various poses (like standing, lying, and tilting) for galaxies. But because every large system (like planetary system, stellar system, and galaxy, etc.) is composed of many celestial objects that are organized in an orderly manner in a series of hierarchical two-body systems, under the effect of gravitation, a successive hierarchical approach between these objects may constrain them to fall on a plane, thereby a planar rotational profile is determined. For instance, reference to Figure 7 ”the hierarchical two-body model”, the Sun and the Mercury under the effect of gravitation are approaching the common center of their mass (point 1). At the same time, both of them via barycenters (point 1 and 2) are exerting gravitation on the planet Venus. This enables point 1 and Venus at the same time to approach point 2. Similarly, point 2 and the barycenter of the Earth-Moon system (point O_1) are also approaching point 3. Point 3 and the Mars are also approaching point 4, etc.. Clearly, it is such a successive hierarchical approach that gets the Sun and all planets constrained to fall on one plane. The initial association of these celestial objects is quiet and dark, but due to the continuous approach, the two objects of a two-body system finally collide together, and then an accretion of material forms one body, the collision may release powerful energy to ignite this body, a star is born. As the collision of two objects is extensive within a series of hierarchical two-body systems, the igniting stars illuminate a larger system to form a galaxy. As the approach of the two components of each two-body system is always continued, smaller structures (if they are galaxies) continue to capture (merge) each other to form larger structures (if there are clusters). In the future planets gradually swallow their satellites; soon after the Sun swallows its planets; the bulge of a galaxy swallows stars; the primary galaxy of a cluster swallows its satellites, etc.

It is well accepted that force is the reason of motion, and motion is the aftermath of force. Hence, it is an appropriate method to seek for the force that is responsible for the motion of celestial objects. Newton follows the heliocentric mode. To explain the stability of the fixed stars, he wrote: “*And lest the system of the fixed stars should, by their gravity, fall on each other, he [God] hath placed those systems at immense distances from one another*.” Newton further wrote that all stars in space are evenly distributed, and the mutual attractions between these stars at the same time are counteracted by their reverse attractions (see Proposition XIV in *Philosophiae Naturalis Principia Mathematica*).

Here we see that the motivation of Newton proposing universal gravitation is to employ this force to constrain all stars in the sky not to move. And now, it may inferred that, because Copernicus’s definition of the universe and the motion of celestial object is incomplete, Newton’s universal gravitation becomes unnecessary. In practice, there are countless stars in the sky, and some of the stars have their planets, and planets also have their satellites, all of them are not only moving, but also belong to some special hierarchical systems (for instance, stellar system, galaxy, cluster, etc.). Such a gigantic number of objects and their hierarchical motions necessarily require a sapiential force to run. Universal gravitation only brings them high entanglement and disorder, while the hierarchical two-body gravitation brings them only orderliness and harmony.

In another sense, the motion of an object appears to indicate that it is ruled by hierarchical two-body gravitation. For instance, the Earth is rotating around its axis, but a person on the Earth’s surface will not come off even though inertia is acting. This is due to the Earth’s gravitation holding on to the person. At the same time, the Earth and the Moon are orbiting around the common center of their mass, the Earth will also not be come off from the Earth-Moon system because of the Moon’s gravitation. As the mass of both the person and the Earth is centralized in a position where it is the common barycenter of their mass, and the person and the Earth are treated as an integral body to orbit the barycenter of the Earth-Moon system, the Moon thus needs through the barycenter of the person and the Earth to exert a force responsible for the integral motion of the person and the Earth. Similarly, the Earth-Moon is also treated as an integral body to orbit the Sun (actually orbiting the barycenter of third two-body system, reference to Figure 7). The Sun thus needs through the barycenter of the Earth-Moon system to exert a force to run the integral motion of the person, the Earth, and the Moon. It is clear that the person participates in three motions at the same time, and each motion is ruled by a kind of force. If Newton’s universal gravitation is employed to understand these motions, it is obviously difficult.

The evidence that Newton used to support universal gravitation is derived from two aspects: 1) the variation of the tide at sea level; and 2) the perturbation of planets. He believes that it is the direct gravitation from both the Sun and the Moon that gives rise to the variation of the tide. However, this claim is not exclusive, as shown in Figure 7 "the hierarchical two-body model". An indirect gravitation from the Sun and a direct gravitation from the Moon can also give rise to the variation of a tide. In fact, Newton only orally claimed the perturbation for Saturn and Jupiter when they are in the conjunction, there is no any observation that may prove the existence of this perturbation.

Kepler's first law stated that the orbit of every planet is an ellipse with the Sun at a focus. Classical mechanics thinks that the effect of force between objects is mutual. Hence, if a planet moves along its elliptical orbit, according to the effect of action and reaction the Sun has to move so as to fit to the motion of this planet. Kepler also believes the heliocentric model that the Sun is at the center of the universe and the Sun is motionless, but this statement apparently contradicts the definition of philosophy that an object is in motion at any time. On the contrary, if the Sun is in motion, then how does the Sun move in space? As all planets are simultaneously in motion and their directions are different, it is impossible for the Sun to be directly responsible for these motions at the same time.

Another problem is how to explain the motion of a planet in the variable gravitational field of the Sun. When a planet moves from aphelion to perihelion, according to Newton's definition, the Sun's gravitation to this planet is increasing. Once the planet reaches its perihelion, the Sun's gravitation becomes the strongest, which disallows escape. But we see that the planet continues to advance after it passes perihelion. The planet itself cannot overcome the Sun's gravity, unless there is another object (third partner) to provide an external force to effectively counteract the Sun's gravitation, otherwise, the Sun will not allow this planet to depart. However, we cannot find an object whose gravity is strong enough to fight against the Sun. Furthermore, with the departure of the planet, the Sun's gravity is decreasing and eventually reaches the minimum at aphelion. It is also hard for us to understand why an ever-decreasing Sun's gravitational pull can compel a departing planet turn around.

On the other hand, Kepler employed the observation of Mars to deduce his laws, and the majority of the observations are made by Tycho Brahe that believes the geocentric model, moreover, the observational item records mainly the inclination of Mars. Also note that the observational instrument before the birth of telescope is very simple and the positional measurement in astronomy is often thought to be very difficult, this determines that it is hard for the observation of Mars at the time to have a good precision. In addition to this, Kepler used a mathematical experience to deduce his laws, because he found that planet often runs a simple elliptical path in space, and then considered this should have a relationship with ellipse that is popular in geometry. Altogether, there are many problems that are unsolvable enough to doubt the accuracy of Kepler's laws.

On the other hand, reference to Figure 7, "the hierarchical two-body model", shows that all problems mentioned above can be soon ruled out. We see, as the Sun and planets are organized in a series of hierarchical two-body systems with gravitation, the Sun is directly responsible for Mercury's motion and indirectly responsible for other planetary movements. As the gravitation between the Sun and planets is indirect (except for Mercury), it is not necessary for us to consider the attracting relationship between them and the resulting energy exchange. As each planet is orbiting around the barycenter of a two-body system, and the Sun has a very massive mass, the positions of the barycenters of related two-body systems are very close to the barycenter of the Sun. Also as the barycenter of each two-body system in practice is invisible, this makes planets look as if they are orbiting around the Sun. Due to this hierarchical two-body arrangement, the planets (excluding Mercury) in their movement can repeatedly approach and depart from the Sun. This determines them to be with ellipse-like orbits with respect to the Sun. Many people often argue that Newton's gravitation has been proven to be very precise in terrestrial scope, but here I have to remind you of a fact.

According to Newton's definition, gravitation between objects is universal and direct, this naturally results in an N-body problem. In the calculation of astrophysical dynamics scientists often simplify this N-body problem into a two-body problem, based on this approximation, they obtain a good result that fits to all the data. However, a key problem is whether there exists a universal gravitation. Based on the hierarchical two-body model, gravitation between objects in essence is hierarchical and indirect, there radically does not exist a N-body problem, the simplification to a fabled N-body problem is therefore unnecessary.

The observable universe is currently thought to be derived from a Big Bang which occurred about 14 billion years ago. If this proposition is tenable, an extrapolation is that when the explosion takes places, ordinary matters due to an explosive impulse would be instantaneously expelled way from a high-dense mass point. With the passage of time, the distances between ordinary matters are continually increasing, which automatically separates matter from each other in space. If gravitation at an earlier time is not strong enough to counteract this separation, the expelling process will be endless, and the present celestial structures will be difficult to form.

On the other hand, if ordinary matter relies on gravitational accretion to form larger lumps, this naturally separates themselves in space. On the whole, to maintain a continuous accretion, it requires some other form of matter to exist. This other form of matter may not exert gravitation on ordinary matter, but it may moderate the motion of expelled ordinary matter so that it does not run away so quickly. Thereby it may provide an impulse effect, like the random molecule bombardment of Brownian motion, that helps separated ordinary matter to have a chance to approach each other. This requirement is necessary, because of what Newton stated in his *Principia*, "*these bodies may, indeed, persevere in their orbits by the mere laws of gravity, yet they could by no means have at first derived the regular position of the orbits themselves from those laws*".

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