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

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Abstract: 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.

This work is a revision of previous version originally published in a proceeding of NPA (Natural Philosophical Alliance) in 2011. Subsequently, we will present a series of works to develop the ideas proposed here.

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 [1]. Unfortunately, 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 [2-6]. The earlier conceptions of galaxies were derived from Wright [7] and Kant [8]. 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 [9], 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 [10]. The current galaxy formation theories focus on larger scale cold dark matter cosmological models [11], and more extensive reviews of this kind of model can be seen in the publications [12-14]. 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 [15-19], this is called galaxy rotation problem. 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. Hubble's discovery of the redshifts of distant galaxies [20] was thought to be a suggestion that the universe is expanding. Today, the conception of the expanding universe has become extraordinarily popular. But unfortunately, most of people had forgotten Hubble's warning in 1936, "... *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*"[21]. In this work we would like to explore this unknowing and hopefully promote our understanding of the universe.

2 Proposition

Because of an unknown significant event, at a special time of t_0, small visible matter (assumed to be ordinary particle) of number N and mass m were evenly scattered in a three-dimensional universe of total volume V (assumed to be V=XYZ, where X, Y, and Z is infinite) and temperature T_0. The density of ordinary particle may be thus written as ρ=Nm/V, the room that each particle occupies in space is expressed as S=V/N. If this room is given as a cube, the average distance between any two particles would be L=$(V/N)^{1/3}$. An evenly distribution of ordinary particles firstly determines a homogeneous and isotropic universe; because of the impulse from another invisible matter, these ordinary particles obtained a kind of random movement; in the movements once two particles approach one another close enough, they gravitationally capture each other to form a clump. It is assumed that the power of gravitation is linearly proportional to mass, namely $R \sim m$. When the power of gravitation between two particles reaches a threshold of L=$(V/N)^{1/3}$ <2R, a capture begins. With the passage of time, temperature decreases gradually. The growth of mass helps promote the power of gravitation of the clump. As the distribution of ordinary particles is extremely extensive, countless clumps of particles are formed at the same time. Subsequently, due to the impulse of unknown matter, these clumps of particle continue to approach and capture each other or single particle to form larger clumps, and at a time of t_1, a considerably large clump of particles is constructed to form a proto-celestial object (Fig.1). At the moment, temperature decreases to T_1; As the distribution of larger clumps is extensive, many proto-celestial objects are formed at the same time. These proto-celestial objects are the seeds of stars, planets, and satellites; and then, due to the impulse of unknown matter, these objects continue to approach and capture each other to form some systems (Fig.2). On large-scale, due to the impulse of unknown matter, these systems continue to approach and capture each other or single object to form larger systems. By order, all objects at a time of t_2 are organized in an orderly series of hierarchical two-body systems that we presently meet (Fig.3). At this moment, temperature decreases to T_2. 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. A numerical treatment of this hierarchical two-body building-up for observable structures will be presented in anther work.

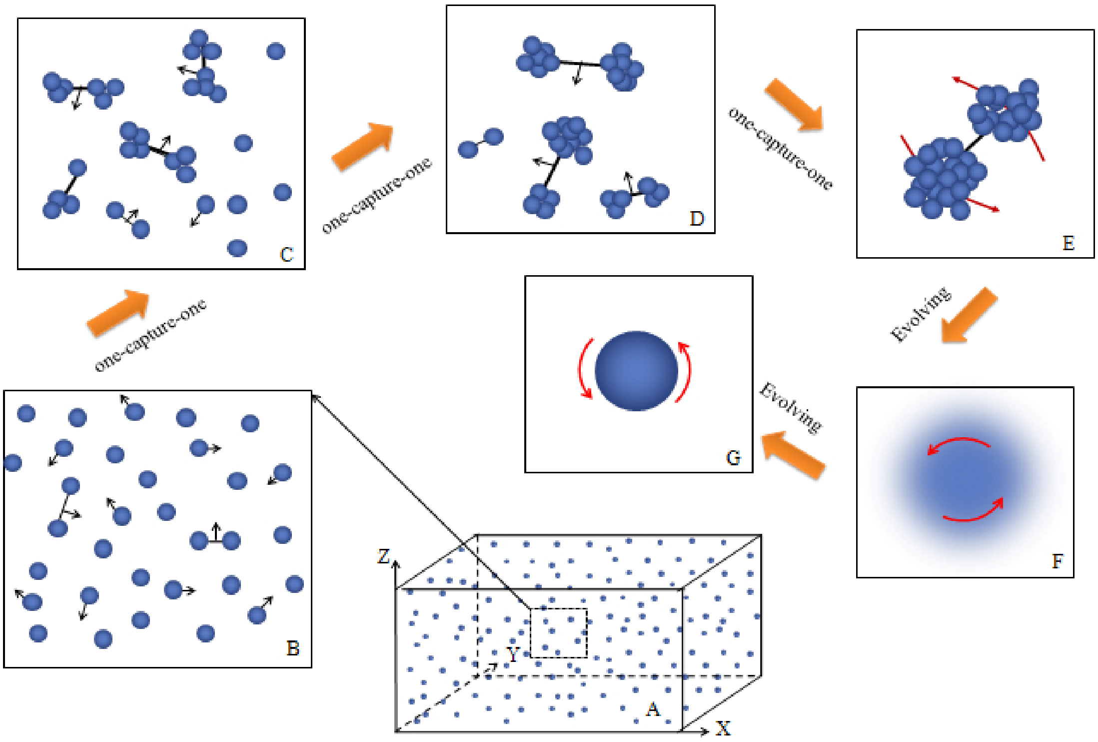


Figure 1: A modelling hierarchical two-body building-up for a primordial celestial object and its motion. Small ordinary particles are evenly distributed in a three-dimensional universe (A). In which, X→∞, Y→∞,and Z →∞; Due to the random movements that are driven by the impulse of another unknown invisible matter, these particles approach and capture each other to form larger lumps (B, C, D, E) until a primordial celestial object is formed (F). The primordial celestial object finally evolves into a spinning object (G). Little black arrows in diagram denote the movements of particles and their lumps. Black line between two lumps (particles) denotes gravitation. Red arrow in diagram (E) represents the motions of the two components of a two-body system.

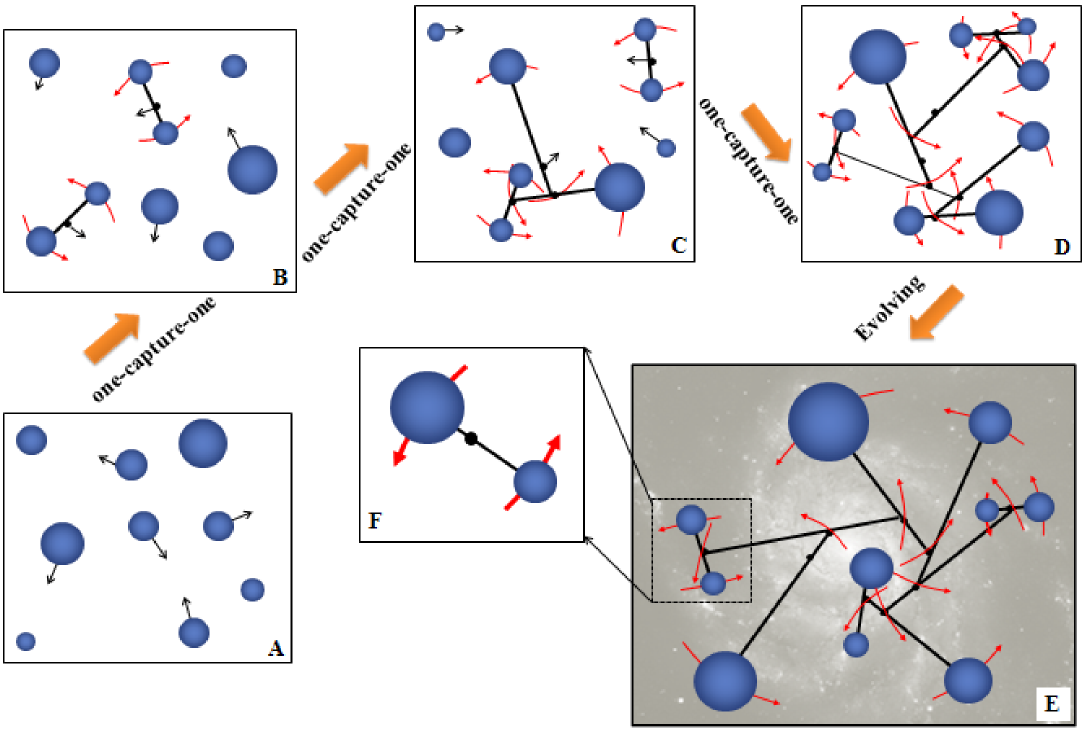


Figure 2: A modelling hierarchical two-body building-up for a large system and its motion. Primordial celestial objects are evenly distributed in a two-dimensional scene (A). Due to the random movements that are driven by the impulse of another invisible matter, these objects approach and capture each other to form a series of two-body systems until a final association is formed (B, C, D). The association finally evolves into a large planar rotational structure (E). The two components of a 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 a two-body system. Lines between objects denote gravitations. Little black dot represents the barycenter of a two-body system. Note that, the background of diagram E is from a spiral galaxy (Photo provided courtesy of NASA).

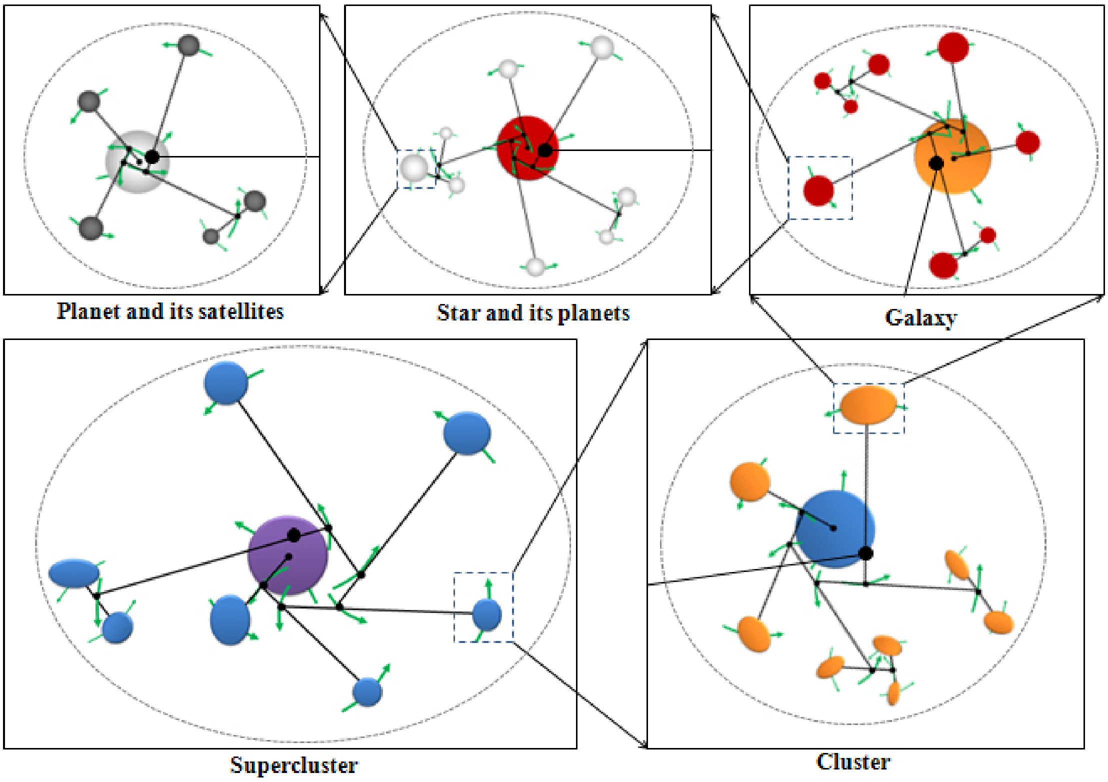


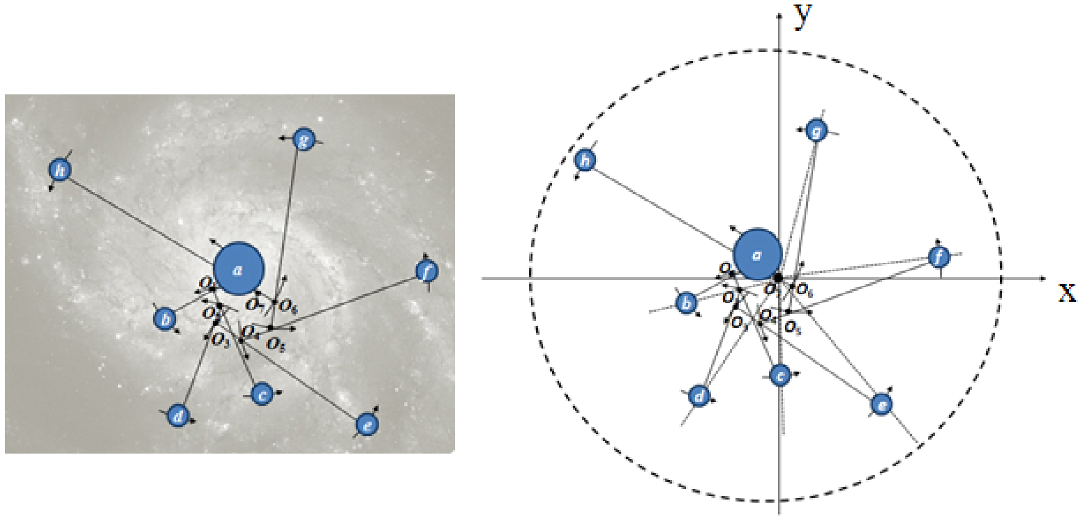
Figure 3: A modelling hierarchical two-body association for larger structures and their motions. Every two-body system connects to a superior two-body system through gravitation (marked with black line). Green arrows represent motion of a component, little black dot represents the barycenter of a two-body system. Dashed circle represents potential room that a hierarchical two system occupies in space.

3 Explanation of astronomical phenomenon

3.1 Galaxy rotation curve

The bulge (as a body) of a galaxy and its nearest star (or multiple stellar system) form first two-body system, and at the same time this two-body system and its second nearest star (or multiple stellar system) form second two-body system, by order, all stars are organized in an orderly series of hierarchical two-body systems. 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. This hierarchical two-body way may yield a flat velocity profile for the motions of the stars of a galaxy and the galaxies of a cluster. The following demonstrate how a flat velocity profile is formed for the motions of stars of a galaxy.

It is firstly assumed that star *a* (may be bulge of a galaxy), *b*, *c*, *d*, *e*, *f*, *g*, and *h* in a disc galaxy are organized in an orderly series of hierarchical two-body systems, in which star *a* and *b* form first two-body system, and at the same time this system and star *c* form second two-body system, by order, the sixth two-body system and star h form final two-body system. Within each of these two-body systems the two components are orbiting the barycenter of this system (Fig.4(A)). We further assume that the orbital radius of each component of a two-body system remains constant. The orbital velocities of these stars are determined as below. Their masses are given as 100m, 10m, 20m, 10m, 30m, 10m, 25m, and 15m, respectively, and the distances from them to galaxy's centre are defined as 0.2r, 0.4r, 0.6r, 0.8r, 1.0r, 1.2r, 1.4r, and 1.6r, respectively. To know the coordinate of each star, we treat the barycenter of a final two-body system (Point O_7) as the center of this galaxy, and the center is further treated as a reference origin to set a rectangular plane coordinate system (Fig.4(B)).



A B

Figure 4: A modelling hierarchical two-body association for the stars of a galaxy and their motions. A): A modelling distribution of sample stars in a disc galaxy. Point O_1, O_2, O_3, O_4, O_5, O_6, and O_7 denote the barycenter of each two-body system, respectively. The black line represents gravitation. Arrows denote the motional directions of stars and related two-body systems. Background image used is by the courtesy of NASA; B): A Cartesian coordinate system is set to calculate the positions of these bodies. Point O_7 is treated as a reference origin of this system.

The inclinations of star a, b, c, d, e, f, g, and h to the x axis are assumed to be 120°, 200°, 280°, 240°, 310°, 25°, 75°, and 150°, respectively. And then, according to a knowledge of geometry, the positions of these stars and related points (O_1, O_2, O_3, O_4, O_5, and O_6, for instance) can be worked out. Since the mass of both star a and b is freely given, to maintain a dynamic stability for the whole system, we need to adjust initial position of star a. Based on these positions, the distance between the two components of each two-body system and the orbital radius of each component may be obtained. The related parameters are listed in Table 1. In such a two-body system the motion of a component fits to a relationship of gravitation and centrifugal force, namely

$m_2 v_2^2/r_2 = k m_1 m_2/r_1^2$ (1)

where the left term is the centrifugal force generated due to the curved motion of this component around a center point, the right term is the gravitational attraction undergone by this component from another. m_1 and m_2 denote respectively the mass of two components of a two-body system, k is coefficient, r_1 is the distance of the two components, and r_2 is the orbital radius that m_2 revolves around the barycenter of this system. It is important to note that, if one component of a two-body system is consisted of by a series of subordinate hierarchical two-body systems, the gravitational force undergone by another component is determined by the total mass of the subordinate hierarchical two-body systems and the distance from this another component to the barycenter of the subordinate hierarchical two-body systems. For example, star e is one component of the fourth two-body system, its partner component consists of a series of subordinate two-body systems that include star a, b, c, and d, therefore, the gravitational attraction undergone by star e is determined by the total mass of star a, b, c, and d, and the distance from star e to the barycenter of the third two-body system, namely

$F_G = k(m_a+m_b+m_c+m_d)m_e/L_{o3e}^2$ (2)

As star e is revolving around O_4 and its orbital radius is L_{o4e}, the centrifugal force aroused by this curved motion may be written as $F_C = m_e v_e^2/L_{o4e}$. And then, according to equation (1), there would be

$v_e = (kL_{o4e}(m_a+m_b+m_c+m_d))^{1/2}/ L_{o3e}$ (3)

By this way, the orbital velocities of these stars are obtained and further compared in Figure 5. It can be found that, except for star a, the velocities of the remaining sample stars are nearly equal in magnitude, forming a flat velocity profile. As te mass of star a is setted as $100m$, which accounts for 45.45% of the total mass of all objects. In addition, the distance from the barycenter of a two-body system to the galaxy's centre is usually less than $0.184r$, and the distance of star a to the galaxy's centre after a correction is $0.15r$, these suggest that, if the body of star a is large enough, this may make the barycenters of all two-body systems generated approximately lie in the body of star a. As star a has a massive mass and the barycenter of each two-body system is invisible, it is feasible to treat the position of star a as the centre 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 in the galaxy is determined by all the mass that is interior to the region of this star, thereby yielding a flat velocity curve for all stars in the galaxy. As the galaxies of a cluster are also orgninzed in a series of hierarchial two-body systems, this feature of flat velocity profile is also suited for the motions of galaxies of a cluster. The motions of stars in galaxy and galaxies in cluster, constrained by this kind of hierarchical two-body way, are well consistent with observations [15-19]. The flat galaxy rotation curve is widely thought to betray the presence of dark matter. Our understanding of the motions of stars and galaxies, however, suggests alternation to dark matter.

Table 1: Parameters of sample stars used in the model

Object	r_1	M	F	r_2
	(r)	(m)	(km^2r^{-2})	(r)
a	0.20(0.15)	100	3338.36	0.02
b	0.40	10	3338.36	0.55
c	0.60	20	4819.25	0.68
d	0.80	10	1312.23	1.00
e	1.00	30	3520.31	1.09
f	1.20	10	1374.38	1.11
g	1.40	25	3242.21	1.18
h	1.60	15	1398.31	1.48

Note that, r_1, the distance from the object to the center of the galaxy; M, the mass of each object; F, the total gravitational attraction undergone by each object; r_2, orbital radius of each object.

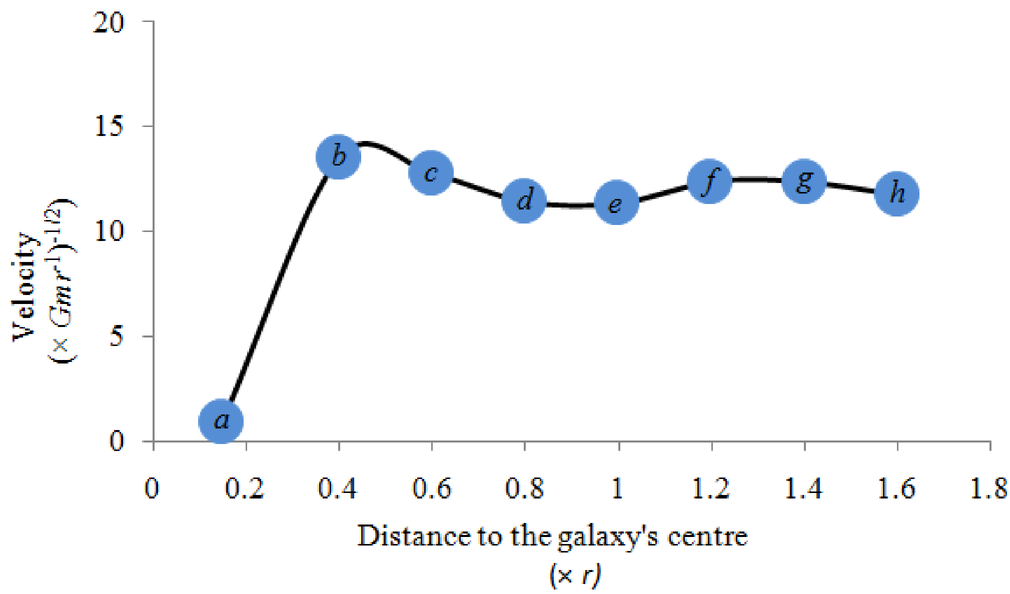


Figure 5: A modelling galaxy rotation curve based on hierarchical two-body model.

3.2 Redshifts of distant galaxies

A hierarchical two-body universe requires a photon emitted from a distant galaxy to overcome a series of hierarchical motions (also gravitations) to reach the Milky Way. This means that, the more distant that a galaxy is from the Milky Way, the more gravitational attraction that the photon emitted from the galaxy needs to fight against. If all the photons hold same level energy at the time when emitted from their father galaxies, and then, the photons that are emitted from distant galaxies would expend more energy in travel than those that are emitted from near galaxies. This excessive consumption may lead their wavelengths to lengthen (spectral lines redshifts). This phenomenon may be outlined with Figure 6. Each photon is given an initial energy level E_0 when emitted, a photon emitted from a distant galaxy (located in cluster 1) in travel expends an energy E_d, and another photon emitted from a near galaxy (located in local group) in travel expends an energy E_n. The two photons respectively hold an energy E_0-E_d and E_0-E_n when they reach the Milky Way. As there are more hierarchical two-body motions between the distant galaxy and the Milky Way than that between the near galaxy and the Milky Way, there should be $E_d > E_n$, subsequently, $(E_0-E_d) < (E_0-E_n)$. According to a relationship of energy and wavelength $E= hc/\lambda$ (where h is Planck's constant, c is the speed of light, and λ is the wavelength of light), there would be $hc/\lambda_d < hc/\lambda_n$, so, $\lambda_d > \lambda_n$, where λ_d and λ_n represent respectively the wavelength of the two photons. This relationship indicates that the wavelength of the photon emitted from distant galaxy would become larger than that of the photon emitted from near galaxy when they reach the Milky Way. In other words, the photon emitted from the distant galaxy performs more redshift than the photon emitted from the near galaxy. This redshift is essentially a result of gravitation.

As the effect of gravitation is to drag objects to approach each other, and all the planets, stars, galaxies, and clusters are organized in a series of hierarchical two-body systems, these two aspects determine that the stellar systems, galaxies, and clusters are shrinking simultaneously. These shrinkages indicate that the gravitational attraction undergone by a photon is being gradually increased if based on an inverse-square law, the increasing gravitational attraction would require subsequent photon emitted to expend more energy than previous photon to reach the Milky Way. As a result, the distant galaxy becomes more and more redshifts with the passage of time. Based on Figure 6, because of a successively hierarchical two-body shrinkage for all clusters and galaxies, local universe is becoming more and more void. In this sense, all distant galaxies appear to increasingly depart from us. The redshifts of distant galaxies [20] was widely thought to be derived from an expanding universe that is due to the existence of dark energy. Our understanding of the redshifts, however, suggests alternation to the expanding universe.

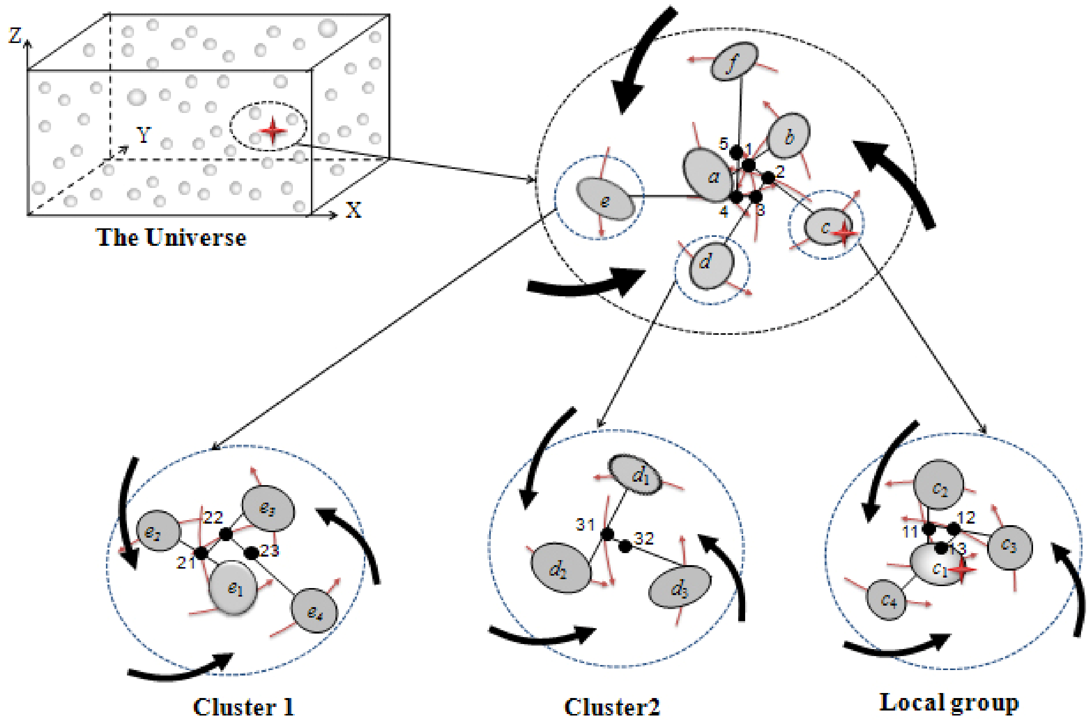


Figure 6: A modelling hierarchical two-body association for clusters and their galaxies. The field is three-dimensional, in which, X→∞, Y→∞,and Z→∞ *a*, *b*, *c*, *d*, *e*, and *f* represent clusters, while c_1, c_2, etc., d_1, d_2, etc., e_1, e_2, etc., represent the galaxies that consist of clusters. Red arrow denotes the motion of each component in a two-body system, while black arrow denotes the shrinkage of a system due to the effect of gravitation. Point 1, 2, 3, etc., 11, 12, etc., 21, 22, etc., 31, 32, etc., represent the barycenter of each two-body system. The observer (marked with red star) is located at the position of the Milky Way Galaxy. Large dashed circle represents the boundary of the field of vision, while small dashed circle represents the boundary of both primary galaxy and their satellites.

Table 2 compares the redshifts of galaxies in local group and nebulae from Hubble's observation. For the 26 satellite galaxies of local group, they are gravitationally dominated by the Milky Way, the Andromeda, and the Triangulum, respectively. The 12 satellite galaxies of the Milky Way have both redshifts and blueshifts. In contrast, NGC 598 of the Triangulum and almost all satellite galaxies (excluding Andromeda IV) of the Andromeda perform buleshifts. As for 24 nebulae from Hubble's observation, except for the 6 nebulae that reside in local group, the remaining commonly display redshifts. As the Milky Way and its satellites consist of a series of hierarchical two-body systems, similar to our solar system, the Milky Way is like the Sun, the satellites are like planets, hence, every satellite looks like orbiting around the Milky Way. As planets in motion can approach and depart from the Sun, these satellites in motion can also approach and depart from the Milky Way, this finally results in a coexistence of the redshifts (for departing satellites) and blueshifts (for approaching satellites). In addition, the Milky Way, the Andromeda, and the Triangulum also consist of two superior hierarchical two-body systems, and because the two components of a two-body system are orbiting around the barycenter of the system, this determine the Andromeda and the Triangulum may approach the Milky Way to form blueshifts for their satellites. This redshift (blueshift) in local group is mainly a result of Doppler's effect.

Table 2: Redshifts of both the most galaxies of local group and the nebulae from Hubble's observation

26 galaxies in local group				nebulae from Hubble's observation [20]			
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.			

Here we provide a solution for the redshifts of distant galaxies. In fact, a lot of explanations in the past had been proposed by cosmologists. These explanations may be roughly divided 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 based on the assumption that Newton's mechanics (universal gravitation) is always valid. A short reasoning may rule out the suspicion hold by Misner, Thorne and Wheeler. 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 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? This is because the motions of objects in space are hierarchical, each object is simultaneously taking part in multiple motions, and each of these motions is being ruled by a force. As a result, it is unnecessary to fear that the high-speed galaxies will be torn apart by the forces that are responsible for these motions.

Are large systems (planetary system, stellar system, galaxy, cluster, for instance) really shrinking? Galaxies and clusters are too distant to be measured during a limited time-scale, but a lot of stellar systems provide such evidence. The binary star system RX J0806.3+1527, based on data from the Chandra X-Ray Observatory, are found to be steadily decreasing orbital period at a rate of 1.2 milliseconds per year. The orbital period of binary star Cen X-3 and SMC X-1 is decreasing at a rate of respectively 1.8×10^{-6} yr^{-1} and 3.36×10^{-6} yr^{-1}[22]. PSR B1913+16 is found to have a rate of decreasing orbital period of 76.5 microseconds per year, and the rate of decrease of semimajor axis is 3.5 meters per year [23]. Orbital decay was also found in the X-ray binary LMC X-4 and Binary PSR B2127+11C [24, 25]. In recent years many hot giant planets are detected to have very short-period orbits in distant solar systems. This feature of short-period orbit suggests that these extrasolar planets could have been giant icy planets formed far enough from their stars that ices could condense, and then have migrated towards their stars [26, 27]. Additionally, geological record of coral fossil shows there were more days per year in the past than in the present, the number of days per year in the early Middle Devonian Period was measured to be 410, and the number of days per month during this period was 31.5 [28-30]. A decrease of the orbital period (radius) of star (planet, satellite) may indicate the shrinkage of a system that it lies in. We believe, the multiple star systems will be the best candidate to test the hierarchical two-body model presented here.

4 Discussion

The approaching direction of the two objects that attempt to form a two-body system determines a final orbit to be circular or elliptical. As shown in Figure 7, when object N approaches object M along path L_1,which is orthogonal, once the distance between them reaches a boundary where the gravitation of object N contacts the gravitation of object M, the two objects begin to move along path S_1 and S_1' to form circular orbits. But when object N approaches object M along path L_2, which is non-orthogonal, the two objects begin to move along path S_2 and S_2' to form elliptical orbits. In most of cases, the approaching direction of the two objects due to random movement could be non-orthogonal, this leads the formed orbits to be mainly elliptical. Please note, the object M(N) also may be a barycenter of a two-body system or a series of subordinate hierarchical two-body systems.

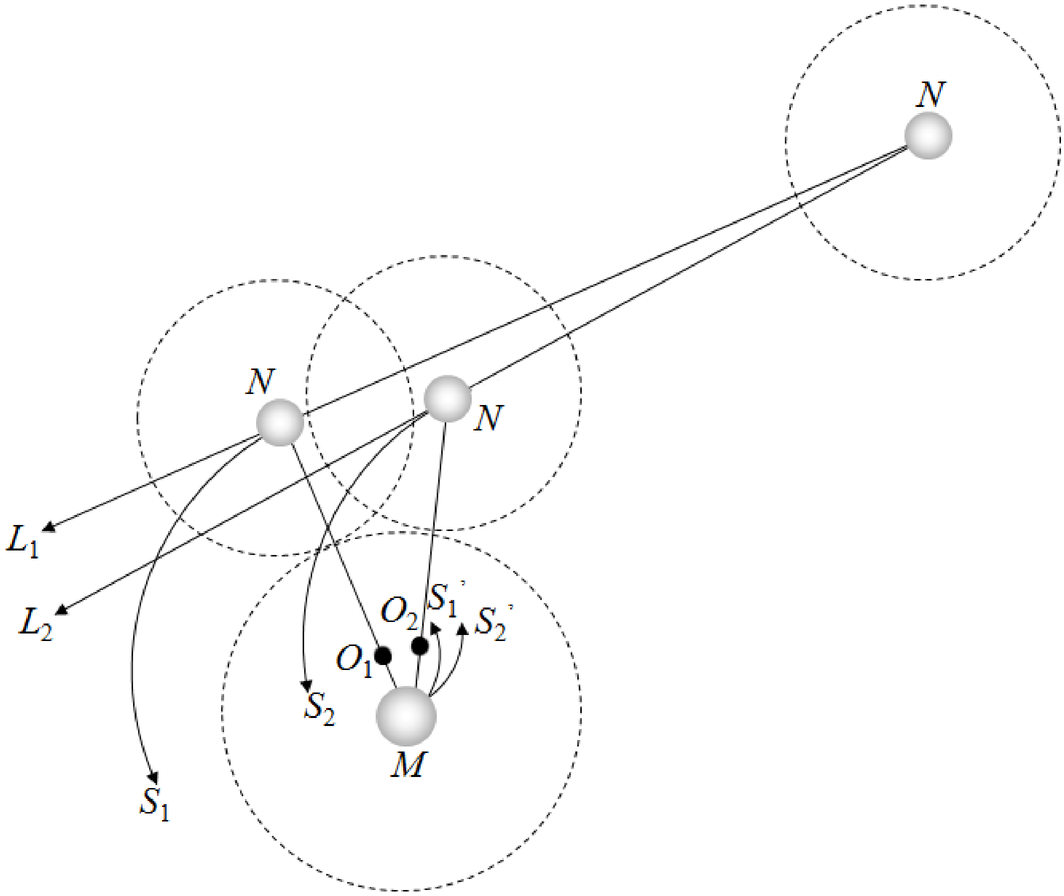


Figure 7: Capture of two objects. Dashed circles represent the gravitational scope of object *M* and object *N*. After capture, the two objects form a two-body system, in which they orbit around point O_1 (O_2) where it is the barycenter of the system.

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 Sun, 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. Additionally, 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 [31]. Recent observation reveals 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 [32]. It is clear to see, the motions of all these objects trend to follow a hierarchical two-body way. Figure 8 compares the established two models and the hierarchical two-body model. In the hierarchical two-body model the Sun and its 8 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 established that the solar system is just one of countless stellar systems that make up the Milky Way, and the Local Group including the Milky Way is also just one of many clusters that make up Local Supercluster. Undoubtedly, there is no a special position for the solar system in the universe. On the whole, the hierarchical two-body model performs more consistent with the observable universe than the geocentric and heliocentric models. For the solar system, the Sun and the Mercury form first two-body system, and at the same time this system and the Venus form second two-body system, by order, the seventh two-body system and the Neptune form the eighth two-body system. Since the Sun holds the majority of mass of the solar system, this makes the barycenter of each two-body system formed approximately lie in the Sun's body, finally, except for the Mercury that is really orbiting the Sun, each of the remaining 7 planets looks like orbiting about the Sun. A more detailed treatment of the motions of the Sun and its planets will be presented in third work.

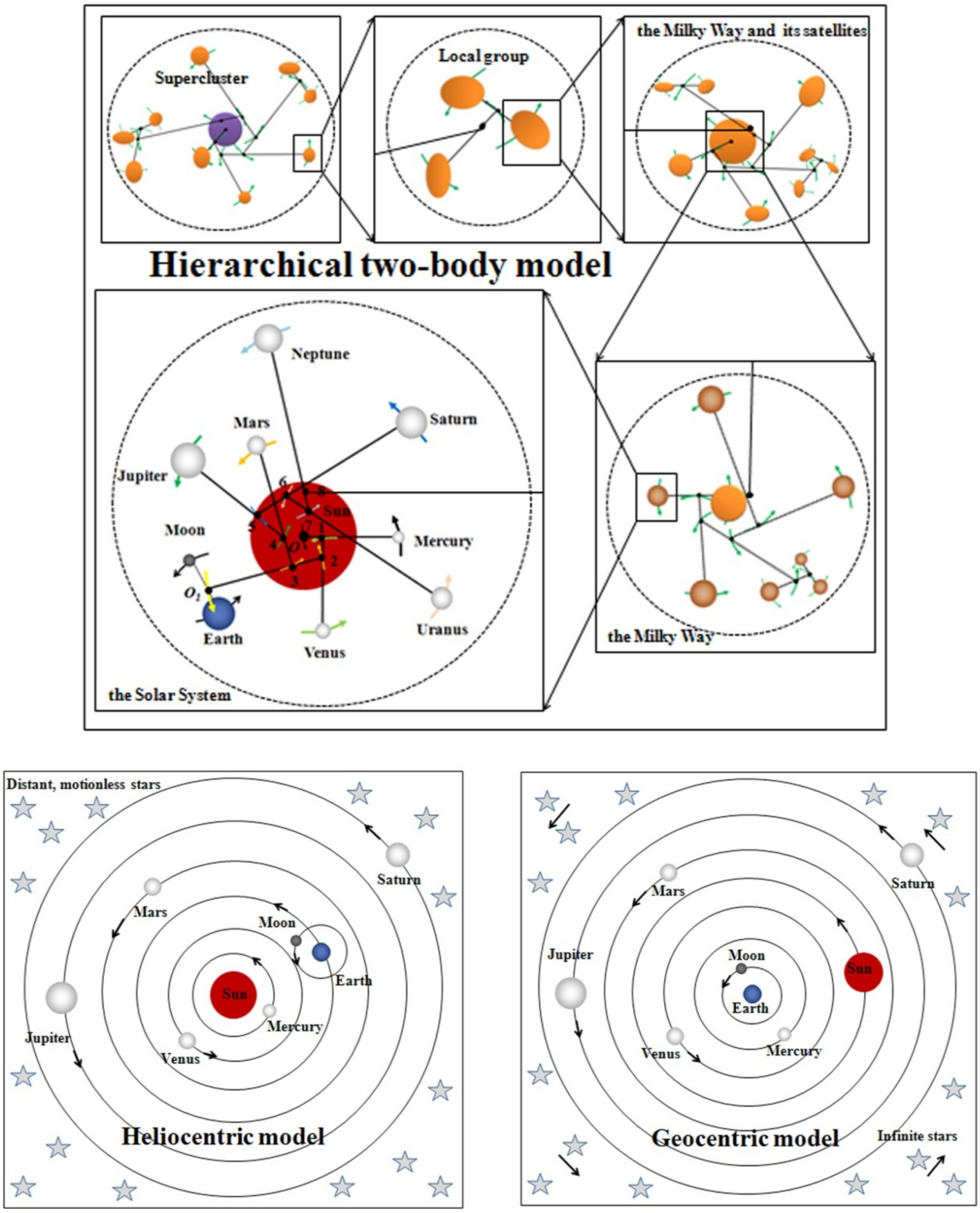


Figure 8: A comparison of the hierarchical two-body model, the heliocentric model, and the geocentric model. In the hierarchical two-body model a subordinate two-body system is always connected to a superior two-body system. Dot 1, 2, 3, etc. respectively denote the barycenter of related two-body system, O denotes the barycenter of the Sun, and O_1 is the barycenter of the Earth-Moon system. Arrow represents the motion of each component. Dashed circle denotes possible boundary of a large system. Colour arrow in the circle denotes the motion of a component. Black line denotes gravitation.

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 [2-6]. In addition, three significant problems also discredit the Solar Nebula Disk Model. On the one hand, some planets (like the four giant planets, Jupiter, Saturn, Uranus, and Neptune) usually have a lot of satellites that form a planetary system, and each of these planetary systems has different inclination with respect 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 trend to fall on the same plane when the collapse takes place, but the various inclinations of these planetary systems don't fit to this expectation. On the other hand, 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 were formed from the collapse of a primordial nebula, this mechanism should be applicable for the formation of other stellar systems, and then, the extrasolar Jovian-mass planets should have the orbits like what in the solar system. Last, observation shows that both the solar system and galaxy are generally with planar rotational profile. In particular, the satellites of Jupiter (Saturn) approximately lie in the same plane. 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 [33, 34]. 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 [35]. This common, planar feature suggests that the formations of all large structures should follow a similar physical mechanism. In consideration of the uncertainties of galaxy formation theories [9-11], we would like to speculate a theoretical modelling for the formation of both stellar system and galaxy: because of a series of dynamical processes, many proto-celestial objects were simultaneously created in space. Subsequently, due to random movements, these objects continue to capture each other to form large systems. On large scale, these systems continue to capture each other or other single objects to form larger systems. By order, all objects are eventually organized in an orderly series of hierarchical two-body systems. The random movements facilitate these objects/systems to approach each other along different directions, by which various declinations for the planets in a stellar system and the satellites in a planetary system, and various poses (like standing, lying, and tilting) for galaxies are finally determined. Since a large system (planetary system, stellar system, and galaxy, for instance) consists of a series of hierarchical two-body systems, a successively hierarchical two-body orbital shrinkage may constrain these objects (systems) to fall on a plane, thereby a planar profile is determined. For instance, refer to Figure 8 ”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), and at the same time both of them via barycenters (point 1 and 2) are exerting gravitation to the Venus, this enables point 1 and the Venus at the same time 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, such a successively hierarchical two-body approach trends to constrain the Sun and these planets to fall towards one plane. The initial association of these objects is quiet and dark, but since the orbital shrinkage continues to proceed, the two objects of a two-body system collide finally, and then an accretion of material forms one body, the collision may release powerful energy. If one of the two objects is gaseous, this energy may help ignite the gaseous one to form a star. The solar system could be formed in such a manner. A successively hierarchical two-body orbital shrinkage determines the collision in a large system may be extensive, many stars may thus be formed at the same time. These stars can illuminate the system to form a galaxy. With the passage of time, smaller structures (if they are galaxies) continue to capture (merge) each other or single object to form larger structures (if there are clusters). A collision of star and star (planet) may form supernova, while a collision of planet (satellite) and planet (satellite) may shatter these bodies into small fragments. A hierarchical two-body gravitation may constrain these fragments to form an asteroid belt (a planetary ring). A detailed treatment of the formation of asteroid belt and planetary ring will be presented in fourth work.

It's already accepted that force is the reason of motion, and motion is the aftermath of force. Hence, by means of the motion of an object, one may search for the force behind this motion. Newton's law of universal gravitation states that every point mass in the universe attracts every other point mass with a force. There are literatures from Newton's *Philosophiae Naturalis Principia Mathematica* to show how he proposed such a force. "*Lastly, if it universally appears, by experiments and astronomical observations, that all bodies about the Earth gravitate towards the Earth, and that in proportion to the quantity of matter which they severally contain; that the Moon likewise, according to the quantity of its matter, gravitates towards the Earth; that, on the other hand, our sea gravitates towards the Moon; and all the planets one towards another; and the comets in like manner towards the Sun; we must, in consequence of this rule, universally allow that all bodies whatsoever are endowed with a principle of mutual gravitation*" (Rule III, Rules of reasoning in philosophy, Book Three system of the word, Originally translated by Andrew Motte). To explain the stability of fixed stars, Newton further 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 believed 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 of *Philosophiae Naturalis Principia Mathematica*). Here we see, Newton followed the heliocentric model and the motivation that he proposed universal gravitation is to employ this force to constrain all stars not to move. Today, the knowledge we hold clearly shows that the Sun is not at the center of the universe, and all distant stars are in motion. Once these ideas of the heliocentric model are disproved, the foundation that Newton proposed universal gravitation would become rootless. Indeed, all bodies about the Earth gravitate towards the Earth, the Moon gravitates towards the Earth, but no observation shows that all planets are gravitating towards one another. The speculation of the Moon attracting sea to form tide is also not substantial. A possible explanation for tide will be presented in fifth work. Most importantly, universal gravitation would lead to entanglement between objects. For example, for the Sun, the Earth, and the Moon, the universal gravitation would at the same time require the Sun to pull the Earth, the Earth to pull the Moon, and the Moon to pull the Sun. This situation is something like that a snake uses its mouth to seize its tail. Such an entanglement is harmful for the motions of the Sun, the Earth, and the Moon. In practice, there are countless stars in the sky, and some of the stars have planets, and planets also have satellites, all of them are not only moving, but also belong to some special hierarchical systems (for instance, stellar system, galaxy, cluster, etc.). Inevitably, universal gravitation brings them highly entanglement and disorders. Facing such a gigantic number of objects and their multiple motions, one cannot refute to consider a sapiential force to manage these motions. Undoubtedly, a hierarchical two-body gravitation is the best candidate. We here use two aspects to argue. On the one hand, the Earth is rotating around its axis, but a person on the Earth's surface will not due to inertia be come off, this fastening ascribes to the Earth's gravitation to the person. At the same time, the Earth and the Moon are orbiting around the barycenter of the Earth-Moon system. 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 only needs via the barycenter of the person and the Earth to exert a force to manage the integral motion of the person and the Earth. Similarly, the Earth-Moon is also treated as an integral body to orbit the Sun, the Sun only needs via the barycenter of the Earth-Moon system to exert a force to manage the integral motion of the person, the Earth, and the Moon. Clearly, the person participates in triple motions at the same time, and each of these motions needs to be ruled by a force. On the other hand, in the solar system there are 8 planets orbiting about the Sun, the centrifugal forces generated by these curved motions need to be separately opposed by the Sun's gravitational attraction. By a relationship of action and reaction, each of these planets also exerts gravitational attraction to the Sun. Lest the Sun falls on each of these planets, the Sun needs to run curved motion to yield centrifugal force to separately oppose each of these planets' attractions, the only way is to arrange the Sun to hierarchically orbit. As shown in Figure 8, the Sun and these planets form 8 hierarchical two-body systems, the Sun simultaneously participates in 8 curved motions, these motions can yield 8 centrifugal forces to separately oppose the Mercury's, the Venus's, the Earth's, the Mars's, the

Jupiter's, the Saturn's, and the Uranus's attraction. On large scale, satellite orbits planet, planet orbits star, star orbits galaxy's center, galaxy orbits cluster's center, etc. Clearly, each of these objects simultaneously participates in multiple motions, to prevent each object escaping from each of these curved motions, it is necessary to employ a series of hierarchical forces to separately hold it.

In the process of capture, ordinary matter relies on gravitational accretion to form large lumps. An increase of mass in the lump extends the scope of gravitation, this may help these lumps to capture more ordinary matter to form larger lumps. We believe, the larger lumps would finally separate themselves in space. To maintain a continuously gravitational accretion, another matter needs to exist. This matter may not exert gravitation to ordinary matter, but it may offer an impulse effect, similar to Brownian motion, to help ordinary matter and the lumps of ordinary matter to approach each other and realize subsequent capture.

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