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Modification of Field Equation and Return of Continuous Creation----- Galaxies Form from Gradual Growth Instead of Gather of Existent Matter

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Abstract: *The paper uncovers the falsehood of big bang and shows the right of continuous creation of matter. In the framework of general relativity, systematically solve the problem of galaxy formation and some significant cosmological difficulties. Einstein's equation of gravitational field is first modified, space-time is proved to be infinite, expansion and contraction of universe are proved to be in circles, the singular point of big bang didn't exist, Besides, it is disclosed that galaxies form from unceasing growth but not the assemblage of existent matter after big bang, new matter continuously creates in the interior of celestial bodies. Celestial bodies, galaxies and space simultaneously enlarge at the same proportion. Also, quite minutely explain gravitational anomalies in solar system such as extra receding rate of lunar orbit after considering tide, the increase of astronom ical unit, the secular change of day length, the earth's temperature rise gradually, the sun is becoming brighter and brighter, as well as the extra acceleration of artificial aerocrafts and so on, these questions can not be treated by current knowledge but can be solved well in the new model.*

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INTRODUCTION

Though general relativity has gotten considerable success, some significant fundamental problems such as the problem of singular point, the problem of horizon, the problem of distribution and existence of dark matter and dark energy, the problem of the formation of stars and galaxies, always are not solved satisfactorily. And again, physicists in the course of dealing with gravitational problems often can not be in a consistent manner, for example the inflation, when it is demanded to explained horizon difficulty it exists, today it is given up due to not being demanded. Another similar case is so-called universal constant question, as people research the motion in a central field it is dumped from gravitational field equation, and as people research the big scope space-time structure it is again picked up to gravitational field equation, obviously such optional choice is never scientific manner, the value of theory lies in being able to interpret uniformly a series of facts to look even no link. Another problem is cosmological research and geophysical research appear more and more separate from each other, this situation should not occur too. In fact, as verification or test to theory cosmological results should reflect the geological appearance on the earth and on the other hand the research to the earth can not disregard cosmological development, for natural world is unified in essence. A sharp instance is that observations show indisputably the earth is expanding but so important phenomenon can not yet obtain due explanation from cosmology or astrophysics until today and even quite a few scientists dare not confront the fact at all. Besides, there are also some logical confusions, for example on one hand say universal temperature descends all the time after big bang and on another hand say the sun is burning more and more brightly, its temperature is becoming higher and higher. In a word, these puzzled problems and phenomenons remain long exposes that our basic theory is not too deep yet and even there are serious mistakes and need further perfection and improvement. In the paper the fundamentals of general relativity are carefully examined and through ameliorating Einstein's gravitational field equation from an all new perspective get these physical or cosmological difficulties removed.

1. Modification of Einstein's field equation and removing of cosmological difficulties

1.1. Modification of Einstein's Gravitational Field Equation

General relativity is a highly symmetrical co-variant gravitational theory, general form of Einstein's field equation [1-2] , which decides space-time metric, is the following equation

$$R_{\mu\nu} = \gamma(T_{\mu\nu} - \frac{1}{2}Tg_{\mu\nu}) \qquad (1.1)$$

where γ is the coupling coefficient, $T_{\mu\nu} \equiv (\rho + p)U_\mu U_\nu + pg_{\mu\nu}$ is the energy-momentum tensor of fluid matter as gravitational source.

Equation (1.1) is a nonlinear equation which determines metric tensor , generally say, it is quite hard to research the general solution and only in weak field general solution can be determined.

In the chapter we renew to solve the static solution of equation (1.1) in weak field of spherical symmetry, but is never simple repeat. Our main purpose is to investigate the more rational weak field approximate solution including the reconfirmation of the coupling coefficient.

Though the topic is "Modification of Einstein's gravitational field equation", our actual work to do is to renew to solve Einstein's gravitational field equation including determining the coupling coefficient, unlike previous work that in advance pressure was assumed as zero in gravitational source, here we takes gravitational source's pressure for unknown quantity and together is solved with the weak field metric as well as the coupling coefficient..

Like previous work our present discussion is still performed in Cartesian right-angle coordinate system, namely four dimension coordinate is $x^\mu = (x^0, x^1, x^2, x^3) = (t, x, y, z)$, and moreover use the natural unit, light speed c=1. In the right-angle coordinate system, Minkowski flat metric is

$$\eta_{\mu\nu} = \begin{pmatrix} \eta_{00} & \eta_{01} & \eta_{02} & \eta_{03} \\ \eta_{10} & \eta_{11} & \eta_{12} & \eta_{13} \\ \eta_{20} & \eta_{21} & \eta_{22} & \eta_{23} \\ \eta_{30} & \eta_{31} & \eta_{32} & \eta_{33} \end{pmatrix} = \begin{pmatrix} -1 & & & \\ & 1 & & \\ & & 1 & \\ & & & 1 \end{pmatrix}$$

According to general relativity, gravitation is explained as space-time curvature, two-rank symmetrical co-variant tensor $g_{\mu\nu}$ can completely describe gravitation, invariant line element is $ds^2 \equiv -d\tau^2 = g_{\mu\nu}dx^\mu dx^\nu$, $s = i\tau$, τ refers to proper time, inverse matrix of $g_{\mu\nu}$ is $g^{\mu\nu}$, it is a two-rank symmetrical contravariant tensor. Contravariant velocity is defined as $U^\mu \equiv \frac{dx^\mu}{d\tau}$, corresponding co-variant velocity is $U_\mu \equiv g_{\mu\nu}U^\nu$, then $U_\mu U^\mu = g_{\mu\nu}U^\nu U^\mu = g_{\mu\nu}\frac{dx^\nu}{d\tau}\frac{dx^\mu}{d\tau} = -1$, $T = g^{\mu\nu}(\rho + p)U_\mu U_\nu + pg^{\mu\nu}g_{\mu\nu} = (\rho + p)U_\mu U^\mu + 4p = 3p - \rho$

In the right-angle coordinate system, for weak field space-time metric can be written as

$$g_{\mu\nu} = h_{\mu\nu} + \eta_{\mu\nu} \ , \ |h_{\mu\nu}| << 1$$

$$\Gamma^\mu_{\alpha\beta} = \frac{1}{2}\eta^{\mu\rho}(\frac{\partial g_{\rho\alpha}}{\partial x^\beta} + \frac{\partial g_{\rho\beta}}{\partial x^\alpha} - \frac{\partial g_{\alpha\beta}}{\partial x^\rho}) , \ h^\mu_\beta = \eta^{\mu\rho}h_{\rho\beta} , \quad h = h^\mu_\mu = \eta^{\mu\rho}h_{\mu\rho} .$$

After omitting smaller than $o(h^2)$ Ricci tensor becomes

$$R_{\mu\nu} = \Gamma^{\sigma}_{\mu\sigma},_{\nu} - \Gamma^{\sigma}_{\mu\nu},_{\sigma} = \frac{1}{2}\ \eta^{\sigma\lambda} h_{\mu\nu,\lambda,\sigma} + \frac{1}{2}(h,_{\mu},_{\nu} - h^{\lambda}_{\mu},_{\lambda},_{\nu} - h^{\sigma}_{\nu},_{\sigma},_{\mu})$$

In the paper semicolons stand for co-variant derivative with respect to corresponding coordinate and commas stand for common derivative, repeated index up and low imply Einstein's summation, and as weak field tensor index go up or down through $\eta^{\mu\nu}$ or $\eta_{\mu\nu}$.

In order to make field equation easy to solve, may as well assume (so-called harmonic condition)

$$h^{\sigma}_{\mu},_{\sigma} = \frac{1}{2} h,_{\mu} \tag{1.2}$$

Take equation (1.2) derivative with respect to x^{ν}, we have

$$h^{\sigma}_{\mu},_{\sigma},_{\nu} = \frac{1}{2} h,_{\mu},_{\nu} \quad \text{and likewise} \quad h^{\sigma}_{\nu},_{\sigma},_{\mu} = \frac{1}{2} h,_{\nu},_{\mu}$$

$$\text{And for } h,_{\nu},_{\mu} = h,_{\mu},_{\nu} \text{ then } h,_{\mu},_{\nu} - h^{\lambda}_{\mu},_{\lambda},_{\nu} - h^{\sigma}_{\nu},_{\sigma},_{\mu} = 0$$

which means field equation (1.1) is decomposed into equation (1.2) and the following

$$\nabla^2 h_{\mu\nu} - \frac{\partial^2 h_{\mu\nu}}{\partial t^2} = 2\gamma(T_{\mu\nu} - \frac{1}{2}T\eta_{\mu\nu}) = 2\gamma[(\rho+p)U_{\mu}U_{\nu} + \frac{\rho-p}{2}\eta_{\mu\nu}]$$

whose diagonal elements have delay solution $h_{\lambda\lambda} = -\frac{\gamma}{4\pi}\int \frac{2(\rho+p)U^2_{\lambda} + (\rho-p)\eta_{\lambda\lambda}}{\xi} dx'dy'dz'$

Here $\xi = \sqrt{(x-x')^2 + (y-y')^2 + (z-z')^2}$, integral is in full space. And for static state $U^j = 0$, $U^0 = 1$, $U_0 = \eta_{0\mu}U^{\mu} = -1$, $U_j = \eta_{j\mu}U^{\mu} = 0$. In order to make sure the external metric components of gravitational source $g_{00} = -1 + \frac{2GM}{r}$ and other three $g_{jj} = 1 - \frac{2GM}{r}$ (**if no**t so, in the distance geodesic cannot reduce to relativistic dynamical equation $\frac{d(m\mathbf{v})}{dt} = -\frac{GMm}{r^3}\mathbf{r}$, M is the mass of source, $m = \frac{m_0}{\sqrt{1-v^2}}$ is kinetic mass of moving particle), obviously the coupling coefficient must be confirmed as $\gamma = 4\pi G$ instead of the previous $-8\pi G$, meanwhile for $r = \sqrt{x^2+y^2+z^2} \geq r_e$, r_e is the source's radius (celestial body), there must exist

$$\int \frac{p}{\xi} dx'dy'dz' = -\int \frac{\rho}{\xi} dx'dy'dz' = -\frac{M}{r}$$

Integral is in full space. In the exterior of the source both p and ρ become vanish, thus get

$$\int p dxdydz = -\int \rho dxdydz = -M\ . \tag{1.3}$$

Again for static state, time reverse must be symmetric, which means $h_{0j} = 0$, space index $j = 1,2,3$.

Next solve the other three h_{ij}. Obviously if use delay solution like diagonal elements, then $h_{ij}=0$, however equation (1.2) can not be satisfied. Thereby we must research nonzero h_{ij}. Note that $h^{\sigma}_{\mu}=\eta^{\sigma\lambda}h_{\lambda\mu}$, $h=\eta^{\nu\lambda}h_{\nu\lambda}=-h_{00}+3h_{11}$, $h_{11}=h_{22}=h_{33}$, $h^{i}_{j}=h_{ij}=h_{ji}=h^{j}_{i}$, $h^{i}_{0}=h_{0i}=0$, $h^{0}_{i}=-h_{0i}=0$, and substituting them into（1.2）we obtain the following three partial differential equations

$$h_{13},_1+h_{23},_2=\frac{1}{2}(h_{11}-h_{00}),_3$$
$$h_{12},_1+h_{23},_3=\frac{1}{2}(h_{11}-h_{00}),_2$$
$$h_{12},_2+h_{13},_3=\frac{1}{2}(h_{11}-h_{00}),_1$$

After differentiating them we get $h_{ij},_i,_j=\frac{1}{4}\left[(h_{11}-h_{00}),_i,_i+(h_{11}-h_{00}),_j,_j-(h_{11}-h_{00}),_k,_k\right]$

here $i\neq j$, $i\neq k$, $k\neq j$, $i,j,k=1,2,3$。 $x^1=x,x^2=y,x^3=z$。For $r\to\infty$, $h_{ij}\to 0$, thus h_{ij} are solved by $h_{ji}=\frac{1}{4}\int_{\infty}^{x^j}\int_{\infty}^{x^i}[(\frac{\partial^2}{\partial(x^i)^2}+\frac{\partial^2}{\partial(x^j)^2}-\frac{\partial^2}{\partial(x^k)^2})(h_{11}-h_{00})]\,dx^i dx^j$

On the other hand, field equation requires $T^{\mu}_{\nu\ ;\mu}=0$, for weak field it means $T^{\mu}_{\nu\ ,\mu}=0$, prove follows.

$R^{\mu}_{\nu\ ;\mu}=R^{\mu}_{\nu\ ,\mu}+\Gamma^{\mu}_{\lambda\mu}R^{\lambda}_{\nu}-\Gamma^{\mu}_{\lambda\nu}R^{\lambda}_{\mu}=R^{\mu}_{\nu\ ,\mu}+o(h^2)=R^{\mu}_{\nu\ ,\mu}$, then

$0=(R^{\mu}_{\nu}-\frac{1}{2}R\delta^{\mu}_{\nu})_{;\mu}=R^{\mu}_{\nu\ ;\mu}-\frac{1}{2}R_{\ ;\nu}=R^{\mu}_{\nu\ ,\mu}-\frac{1}{2}R_{,\nu}$, on the other hand field equation gives

$R=-\gamma T$ and $R^{\mu}_{\nu\ ,\mu}=\gamma(T^{\mu}_{\nu}-\frac{1}{2}T\delta^{\mu}_{\nu})_{,\mu}=\gamma(T^{\mu}_{\nu\ ,\mu}-\frac{1}{2}T_{,\nu})=\gamma T^{\mu}_{\nu\ ,\mu}+\frac{1}{2}R_{\ ,\nu}$, hence $T^{\mu}_{\nu\ ,\mu}=0$.

For static state, $T_{\nu\ ,\mu}^{\ \mu}=[(\rho+p)U_{\nu}U^{\mu}]_{,\mu}+(p\delta^{\mu}_{\nu})_{,\mu}=p_{,\nu}=0$ imply p is unchanged in the interior of source, and using $\nabla^2(h_{00}-h_{jj})=\nabla^2 h_{00}-\nabla^2 h_{jj}=16\pi Gp$, it is verified that

$$\nabla^2 h_{ji}=\frac{1}{4}\int_{\infty}^{x^j}\int_{\infty}^{x^i}[(\frac{\partial^2}{\partial(x^i)^2}+\frac{\partial^2}{\partial(x^j)^2}-\frac{\partial^2}{\partial(x^k)^2})\nabla^2(h_{11}-h_{00})]\,dx^i dx^j=0$$

So far all the metric components are determined. It is considerable that from equation (1.3) we conclude that $p=-\overline{\rho}$ (bar means average), obviously when matter density is uniform pressure $p=-\overline{\rho}=-\rho$, which is very important because is fit to describe the isotropic universal space.

Now the coupling coefficient is reconfirmed as $4\pi G$ to replace the previous $-8\pi G$, corresponding pressure as gravitational source takes negative, Einstein's field equation is specified as

$$R_{\mu\nu}-\frac{1}{2}Rg_{\mu\nu}=4\pi GT_{\mu\nu} \qquad (1.4)$$

Compared with the previous $R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} = -8\pi G T_{\mu\nu}$, equation (1.4) is obviously a revision, but the structure of field equation doesn't change. Derived with the artificial assumption in advance that interior pressure of source is zero, coefficient $-8\pi G$ has a congenitally deficient, and besides, the more serious is that the metric given by the previous field equation cannot make geodesic reduce to relativistic dynamic equation in the distance, it offers unsuitable metric components $g_{jj} = 1 + \frac{2GM}{r}$ but not the correct $g_{jj} = 1 - \frac{2GM}{r}$.

Note that the meaning of derivative of coordinate with respect to proper time τ isn't clear, when we use geodesic $\frac{d^2 x^\mu}{d\tau^2} + \Gamma^\mu_{\nu\lambda} \frac{dx^\nu}{d\tau} \cdot \frac{dx^\lambda}{d\tau} = 0$ to solve acceleration or velocity the proper time τ need be eliminated so as to compare with the relativistic dynamic equation $\frac{d(m\mathbf{v})}{dt} = -\frac{GMm}{r^3}\mathbf{r}$, and eliminating proper time geodesic is

$$\frac{d^2 x^\mu}{dt^2} + \Gamma^\mu_{\nu\lambda} \frac{dx^\nu}{dt} \cdot \frac{dx^\lambda}{dt} - \Gamma^0_{\nu\lambda} \frac{dx^\nu}{dt} \cdot \frac{dx^\lambda}{dt} \cdot \frac{dx^\mu}{dt} = 0 \qquad (1.5)$$

in which the derivatives of coordinate with respect to time *t are* usual speed and acceleration, their physical meanings are clear. Equation (1.5) is a basic formula of post Newtonian mechanics. Substituting the weal field metric solved above into equation（1.5）can prove equation (1.5) to reduce to

$$\frac{d(m\mathbf{v})}{dt} = -\frac{GMm}{r^3}\mathbf{r}$$

May as well take the motion along X-axis for example, $\Gamma^1_{00} = \frac{GM}{x^2}$, $\Gamma^1_{11} = \frac{GM}{x^2}$, $\Gamma^0_{01} = \frac{GM}{x^2}$, $\frac{dy}{dt} = \frac{dz}{dt} = 0$, $v_x = \frac{dx}{dt}$, equation (1.5) becomes $\frac{d^2 x}{dt^2} + \Gamma^1_{00} + \Gamma^1_{11} \frac{dx}{dt} \cdot \frac{dx}{dt} - 2\Gamma^0_{10} \frac{dx}{dt} \cdot \frac{dx}{dt} = 0$, namely $\frac{d^2 x}{dt^2} + (1 - v_x^2)\frac{GM}{x^2} = 0$, which is just $\frac{d(mv_x)}{dt} = -\frac{GMm}{x^2}$, $m = m_0 / \sqrt{1 - v_x^2}$. In fact, $\frac{d}{dt}[mv_x] = m_0 [v_x \frac{d(1 - v_x^2)^{-1/2}}{dt} + (1 - v_x^2)^{-1/2} \frac{dv_x}{dt}] = (1 - v_x^2)^{-3/2} \frac{d^2 x}{dt^2} m_0 = m(1 - v_x^2)^{-1} \frac{d^2 x}{dt^2}$.

Obviously if $g_{11} = 1 + \frac{2GM}{r}$, $\Gamma^1_{11} = -\frac{GM}{x^2}$, then equation (1.5) becomes $\frac{d^2 x}{dt^2} + (1 - 3v_x^2)\frac{GM}{x^2} = 0$, which is different from $\frac{d(mv_x)}{dt} = -\frac{GMm}{x^2}$ and goes against the principle light speed is limit speed and thus is wrong .

And finally, it must be pointed out that the equation, which describes the motion of fluid, doesn't refuse negative pressure, in classical mechanics only the gradient of pressure appears in equation of motion, the absolute value of pressure can changes within an arbitrary constant, and in relativity the absolute value need be specified and isn't arbitrary, the appearance of negative pressure is the request of confirming the absolute value and isn't worth surprise [3].

1.2. The Principle of Equal-Density Expansion of Celestial Bodies

Applying $T^{\mu\nu}{}_{;\nu}=0$ to the interior of a celestial body, note that $g_{\mu\nu;\alpha}=0$, $g^{\mu\nu}{}_{;\alpha}=0$, $(nU^{\alpha})_{;\alpha}=0$, $0=(U_{\beta}U^{\beta})_{;\alpha}=U_{\beta}U^{\beta}{}_{;\alpha}+U_{\beta;\alpha}U^{\beta}=U_{\beta}U^{\beta}{}_{;\alpha}+(g_{\mu\beta}U^{\mu})_{;\alpha}U^{\beta}=2U_{\beta}U^{\beta}{}_{;\alpha}$

$0=d\tau U_{\alpha}T^{\alpha\beta}{}_{;\beta}=dp-d\tau\left[(\rho+p)U^{\beta}\right]_{;\beta}=dp-nd(\frac{\rho+p}{n})=-n(pd\frac{1}{n}+d\frac{\rho}{n})$, where n is number density of particle in the body, further we get

$$pd\frac{1}{n}+d\frac{\rho}{n}=0 \qquad (1.6)$$

Obvious $\frac{1}{n}$ stands for single-particle volume and $\frac{\rho}{n}$ stands for single-particle mass. Of course, here so-called particle not always mean molecule or atom, it may denote a small part of the body. May as well look whole celestial body as a particle, that is to say, $n=\frac{1}{V}$, here equation (1.6) becomes

$$dm=d(\rho V)=-pdV \qquad (1.7)$$

V is volume of the body and m is its mass. Obviously, as $p=-\rho$, we have $d\rho=0$, namely $\rho=const$, which indicates that the density doesn't change in the course of the expansion of celestial body and new matter inevitably creates continuously in the interior of celestial body. As for the micro mechanism of the creation belongs to other question and will still be discussed in the back. Certainly, equation (1.7) is fit to describe a galaxy, when describe a galaxy ρ and p are the statistic average density and pressure in the scope of the galaxy, respectively. And for galaxy there exists similarly $p=-\rho$.

As application we prove that if celestial celestial bodies, galaxies and space expand synchronously namely their expansion is at the same proportion, universal density is invariant.

In fact, in space select a volume V_1, a sphere of radius r_1 (refer to Figure 1), and V_2 and ρ_2 are respectively the volume and density of the body inside V_1, its radius is r_2. Then in volume V_1 the even density of matter is $\rho_1=\frac{m}{V_1}=\frac{\rho_2 V_2}{V_1}$, m is mass of the body and ρ_2 is invariant in the course of the body's expansion, synchronous expansion (equal-proportion expansion) means $v_1=Hr_1$, $r_1=f_1R(t)$, $V_1=k_1R^3(t)$, and $v_2=Hr_2$, $r_2=f_2R(t)$, $V_2=k_2R^3(t)$, and k_1, k_2, f_1, f_2 are constants, $R(t)$ is the scale factor of universe, we conclude that

$$\rho_1=\frac{m}{V_1}=\frac{\rho_2 V_2}{V_1}=\frac{\rho_2 k_2 R^3(t)}{k_1 R^3(t)}=\frac{\rho_2 k_2}{k_1}=const$$

And when the selected volume V_1 is large enough ρ_1 is just the so-called universal density. Of course, here proof is simplified, actual celestial body or galaxy inside V_1 is not always a standard sphere, however we can suppose to divide them into some spheres to treat.

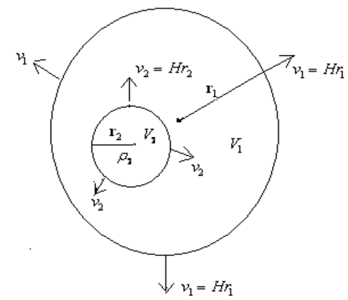

Fig1. *Sketch map to describe space and body expand together*

1.3. Application and Test of Equation (1.4) to Cosmology

It is decided by practice in the final analysis whether a theory is right or not. The application of equation (1.4) in cosmology shows strongly that the revised field equation (1.4) is quite successful. With l as standard radial coordinate, in the co-moving coordinate system Robertson-Walker metric [2-4], which describes isotropic universal space, is given by

$$ds^2 = -dt^2 + R^2(t)\left[\frac{1}{1-kl^2}dl^2 + l^2 d\theta^2 + l^2 \sin^2\theta d\varphi^2\right]$$

$R(t)$ is called universal scale factor, which is already mentioned above. And the proper distance between point (t,l,θ,φ) and the point $(t,0,0,0)$ is defined as $d_p = R(t)\int_0^l \frac{1}{\sqrt{1-kl^2}}dl$, proper speed $v_p = Hd_p$, which means universal expansion may exceed light velocity if d_p enough big, here $H \equiv \frac{dR}{Rdt}$, space-time coordinate $x^\mu = (x^0, x^1, x^2, x^3) = (t,l,\theta,\varphi)$, and nonzero metric $g_{00} = -1$, $g_{11} = \frac{R^2(t)}{1-kl^2}$, $g_{22} = R^2(t)l^2$, $g_{33} = R^2(t)l^2\sin^2\theta$. Substituting them into $R_{\mu\nu} = 4\pi G(T_{\mu\nu} - \frac{1}{2}Tg_{\mu\nu})$ gets two independent equations

$$\left(\frac{dR}{dt}\right)^2 + k = -\frac{4\pi G}{3}\rho R^2 \qquad (1.8)$$

$$\frac{d\rho}{dt}R + 3\frac{dR}{dt}(p+\rho) = 0 \qquad (1.9)$$

Consequently the constant k must be negative, so far universe is proved infinite. It no longer depends on so-called critical density whether universe is infinite or not. (1.9) can be rewritten $d(\rho a^3) + pda^3 = 0$, which express the sum of negative and positive energy in universe is zero all the time. For isotropic universe, we can use the condition $p = -\rho(t)$ derived above, then $\dot{\rho} = 0$ or

$$p = -\rho = const, \qquad (1.10)$$

from above discussion which indicates that celestial bodies, galaxies, space together expand at the same proportion, celestial bodies or galaxies expand equal-density, mass of any celestial body or galaxy changes with time to meet $m/V = m/kR^3(t) = const$, that is to say, at arbitrary two moments t_1, t_2

$$\frac{m(t_1)}{m(t_2)} = \frac{R^3(t_1)}{R^3(t_2)} \qquad (1.11)$$

(1.11) shows that galaxies form from continuous growth. Recent observations found X-shaped structure [5] in the central of Milky Way, which implies big galaxies doesn't come from combination of different galaxies and consistent with (1.11).

It must be point out that the increase of star or galaxy mass doesn't really mean the violation of energy conserved law, because such increase is the result for the negative pressure to do work [3], namely the conversion of work and energy.

Moreover, solving equation (1.8) we have

$$R(t) = A\sin\left(t\sqrt{\frac{4\pi G\rho}{3}}\right). \qquad (1.12)$$

Here A is chosen as a positive constant. So far universal expansion and contraction are proved to be in circles like a harmonic oscillator, and time doesn't have a beginning. No beginning for time is conformable with infinity of universal space and again proves that time and space is inseparable and united. Note that according to the definition, the horizon of universe at moment $t > 0$ is now, in the light of (1.12)

$$d_h(t) \equiv R(t)\int_0^t \frac{1}{R(t)}dt = \sin\left(t\sqrt{\frac{4\pi G\rho}{3}}\right)\int_0^t \frac{dt}{\sin\left(t\sqrt{\frac{4\pi G\rho}{3}}\right)} = \infty \qquad (1.13)$$

So-called horizon puzzle does not exist, observed in any time universe is infinite. Since any observation needs a time interval, the status that universal size is zero isn't observable even at time R(t)=0. We think universal size is zero as R (t) = 0, but such status is unobservable, universe looks infinite at any time.

Assume that at time t_e light of frequency ν_e was given out from a galaxy, easily prove $\frac{R(t_e)}{R(t_0)} = \frac{\nu_0}{\nu_e}$, subscript "0" refers to today, then re-shift $z = \frac{\lambda_0 - \lambda_e}{\lambda_e} = \frac{R(t_0)}{R(t_e)} - 1$. May as well putting $R(t_0) = 1$, and differentiating $1 + z = \frac{1}{R(t)}$ get $dz = -\frac{dR}{R^2(t)} = -\frac{dR}{Rdt}\frac{dt}{R} = -H\frac{dt}{R}$, namely $\frac{dz}{H} = -\frac{dt}{R}$. Writing $\frac{4\pi G\rho}{3H_0^2} = q_0$, $H(t_0) = H_0$, from equation (1.8) $q = \frac{4\pi G\rho}{3H^2} = -\frac{R\ddot{R}}{\dot{R}^2}$, thus q is deceleration factor, $k = -H_0^2(1+q_0)$, $H \equiv \frac{dR}{Rdt} = H_0\sqrt{(1+q_0)(1+z)^2 - q_0}$, . For light,

$\frac{dt}{R(t)} = -\frac{dz}{H} = -\frac{dl}{\sqrt{(1-kl^2)}}$, $\int_0^z \frac{dz}{H} = \int_0^{l_a} \frac{dl}{\sqrt{1-kl^2}}$. l_a is galaxy's invariant coordinate, luminosity-distance

$d_L = (1+z)\int_0^{l_a} \frac{dl}{\sqrt{1-kl^2}}$, we get

$$H_0 d_L = \frac{z+1}{\sqrt{q_0+1}} \ln \frac{(z+1)\sqrt{q_0+1} + \sqrt{(q_0+1)(z+1)^2 - q_0}}{1+\sqrt{q_0+1}} \tag{1.14}$$

It is a new relation between distance and re-shift. And as $z \to 0$, expanding the right hand side of (1.14) into power series with respect of z gets $H_0 d_L = z + \frac{1-q_0}{2} z^2 + \frac{3q_0^{\,2} - 2q_0 - 1}{6} z^3 + \cdots$,

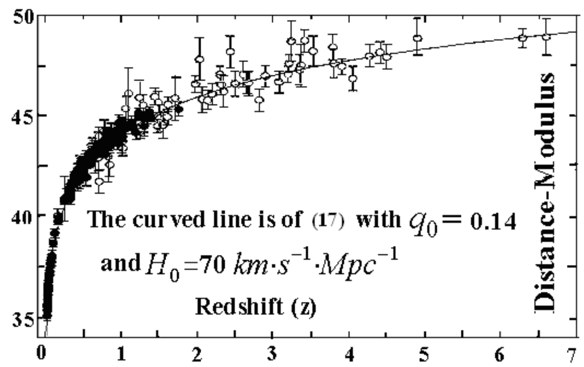

Fig2. *The Recent Hubble diagram of 69 GRBs and 192 SNe Ia*

The curved line in Figure 2 is the image of function (1.13)with $q_0 = 0.14$ and $H_0 = 70 km \cdot s^{-1} \cdot Mpc^{-1}$. q_0 is deceleration factor and H_0 is Hubble parameter of today. the situation described by the curved line agrees well with the recent observations [6-12] and powerfully proves the ameliorated field equation (1.4) successful.

Recent observations show that $q_0 = \frac{4\pi G\rho}{3H_0^2} \equiv \frac{\Omega_0}{2} = 0.1 \pm 0.05$. Note that Distance-Modulus is equal to $5\lg d_L + 25$, unit of d_L is Mp. Next we derive "our universal age", namely the time from last $R(t) = 0$ (at the moment, t may as well take 0) to today. With $H = \frac{dR}{Rdt} = 2\sqrt{\frac{\pi G\rho}{3}} ctg\left(2t\sqrt{\frac{\pi G\rho}{3}}\right)$,

$q_0 = 0.14$, "our universal age "is

$$t_0 = \frac{tg^{-1}\sqrt{q_0}}{H_0\sqrt{q_0}} = 1.37 \times 10^{10} yr, \tag{1.15}$$

1.4. Cracking of the Puzzle of Dark Matter

The negative pressure as important gravitational source is invisible, and it is the negative pressure that appears as the role of dark matter and leads to the phenomenon of missing mass, or say that so-called dark matter is just the effect of the negative pressure , prove as follows.

Speaking generally, within a galaxy the metric field is weak field, and may as well look a galaxy as a celestial body, according to the above discussion, within the galaxy ($0 \le r \le r_e$) from (1.3)

$$p = const = -\frac{3M}{4\pi r_e^3}, \text{ and } \quad h_{00} = -G\int \frac{\rho + 3p}{\xi} dx'dy'dz' =$$

$$-4\pi G\left(r^{-1}\int_0^r \rho r^2 dr + \int_0^{r_e} \rho r dr - \int_0^r \rho r dr\right) - 6G\pi p r_e^2 + 2G\pi p r^2$$

According to geodesic equation the gravity acceleration within the galaxy is given by

$$g = -\Gamma^1_{00} = \frac{1}{2}\frac{dh_{00}}{dr} = 2\pi G p r + \frac{2\pi G}{r^2}\int_0^r \rho r^2 dr = 2\pi G p r + \frac{Gm(r)}{2r^2} \tag{1.16}$$

where $m(r) \equiv 4\pi\int_0^r \rho r^2 dr$, and g may be positive or negative since pressure is negative, and the negative g indicates the direction of acceleration is towards the center. And the corresponding orbital speed v_T is

$$v_T{}^2 = -gr = -2\pi G p r^2 - \frac{Gm(r)}{2r} \quad , \tag{1.17}$$

(1.17) tells that when $m(r)$ is even on the verge of zero near the center of the galaxy the speed v can also become high, this explains so-called missing mass.

1.5. Exact solution of (1.4) in the case of spherical symmetry in the background coordinate system

Firstly, we decide external exact solution of (1.4). Outside ρ=0, p=0, (1.4) becomes $R_{\mu\nu} = 0$ whose static spherical symmetric solution was given by Schwarzschild in the standard coordinate system

$$ds^2 \equiv -d\tau^2 = -\left(1 - \frac{2GM}{l}\right)dt^2 + \left(1 - \frac{2GM}{l}\right)^{-1} dl^2 + l^2(d\theta^2 + \sin^2\theta d\varphi^2) \tag{1.18}$$

M is mass of source; l is called standard radial coordinate or radial parameter, its physical meaning isn't too clear and only in the far field can be viewed as radius vector. In order to describe clearly position of gravitational field and enable general relativity to have common language with other theories and compare result one another, it is necessary to transform equation (1.18) into the form expressed in background coordinates. Hence we take transformation $l = l(r)$. r is usual radius and also call background coordinate [2-4], t, θ, φ are standard coordinates and can also be viewed as background coordinates, namely usual time and angle. Now we try to determine the specific form of $l = l(r)$. For the sake, we introduce a transformation equation

$$\frac{dl}{dr} = \sqrt{1 - \frac{2GM}{l}} \exp(-\frac{GM}{r}) \tag{1.19}$$

The correctness of equation (1.19) will be seen later. Separating variables gives the solution

$$\sqrt{l(l - 2GM)} + 2GM \ln\left(\sqrt{l} + \sqrt{l - 2GM}\right) = C_1 + r - GM \ln r - \frac{1}{2r}G^2M^2 + \frac{1}{12r^2}G^3M^3 + \cdots \tag{1.20}$$

(1.20) defines a coordinate transformation $l \to r$. Here constant C_1 is determined from the continuity of function $l = l(r)$ on the boundary of source, and the back equation (1.26) gives the boundary value $l(r_e)$, r_e denotes source's radius (celestial body radius). And obviously $l \approx r$ for $r \to \infty$. In fact, equation (1.19) gives $l \to \infty$ for $r \to \infty$, and considering of $\lim_{x \to \infty} \frac{\ln x}{x} = 0$, for $l \to \infty$ the left-hand side of (1.20) is $l\left(\sqrt{1-\frac{2GM}{l}} - \frac{GM}{l}\ln l - \frac{2GM}{l}\ln\left(1+\sqrt{1-\frac{2GM}{l}}\right)\right) \approx l$, and for $r \to \infty$, the right-hand side of (1.20) is $r\left(\frac{C_1}{r} + 1 - \frac{GM}{r}\ln r - \frac{G^2M^2}{2r^2} + \frac{G^3M^3}{12r^3} + \cdots\right) \approx r$. (1.18) is transformed into the following

$$ds^2 = -\left(1-\frac{2GM}{l}\right)dt^2 + \exp(-\frac{2GM}{r})dr^2 + l^2\left(d\theta^2 + \sin^2\theta d\varphi^2\right) \quad . \tag{1.21}$$

Note that now $l = l(r)$ is already a concrete implicit function with respect to r, confirmed by (1.20 **)**, that is to say, with t, r, θ, φ as independent variables (1.21) is the solution of vacuum field $R_{\mu\nu} = 0$.

In the distance, equation (1.21) provides $g_{00} = -1 + \frac{2GM}{l(r)} \approx -1 + \frac{2GM}{r}$, $g_{11} = \exp(-\frac{2GM}{r}) \approx 1 - \frac{2GM}{r}$, $g_{22} = l^2(r) \approx r^2$, $g_{33} = l^2(r)\sin^2\theta \approx r^2\sin^2\theta$, $\Gamma^1_{00} \approx \frac{GM}{r^2}$, $\Gamma^1_{11} \approx \frac{GM}{r^2}$, $\Gamma^0_{01} \approx \frac{GM}{r^2}$, $\Gamma^1_{01} \approx 0$, $\Gamma^0_{00} = 0$, and introducing them into equation (1.5) for radial motion, $d\theta = d\varphi = 0$, $v = \frac{dr}{dt}$, we get

$$\frac{d^2r}{dt^2} + (1-v^2)\frac{GM}{r^2} = 0 \, , \tag{1.22}$$

which is just the relativistic dynamic equation, therefore we say that the introduction of equation (1.19) is seasonable and not only line element (1.21) is a solution of field equation but also meets physical requirement.

Now explain why l can not be given the meaning of background coordinate. In fact, if directly put $l = r$ equation (1.18) becomes

$$ds^2 = -\left(1-\frac{2GM}{r}\right)dt^2 + \left(1-\frac{2GM}{r}\right)^{-1}dr^2 + r^2(d\theta^2 + \sin^2\theta d\varphi^2) \, . \tag{1.23}$$

Obviously it provide $g_{00} = -1 + \frac{2GM}{r}$, $g_{11} = \left(1-\frac{2GM}{r}\right)^{-1}$, $g_{22} = r^2$, $g_{33} = r^2\sin^2\theta$, $g_{\mu\nu} = 0(\mu \neq \nu)$,

$\Gamma^1_{11} = \frac{1}{2}g^{1\rho}\left(\frac{\partial g_{\rho 1}}{\partial x^1} + \frac{\partial g_{\rho 1}}{\partial x^1} - \frac{\partial g_{11}}{\partial x^\rho}\right) = -\frac{GM}{(1-2GM/r)r^2}$, $\Gamma^0_{01} = \frac{GM}{(1-2GM/r)r^2}$, $\Gamma^1_{00} = \frac{(1-2GM/r)GM}{r^2}$

$\Gamma^1_{01} = 0$, and substituting them into (1.5) for radial motion $d\varphi = d\theta = 0$ we have

$\frac{d^2r}{dt^2} = -\Gamma^1_{00} - \Gamma^1_{11}v^2 + 2v^2\Gamma^0_{01} = -(1-\frac{2GM}{r})\frac{GM}{r^2} + \frac{3GM}{(1-2GM/r)r^2}v^2$, in the distance it reduces to

$\frac{d^2r}{dt^2} + (1-3v^2)\frac{GM}{r^2} = 0$ which is not the relativistic dynamical equation.

Note that the angle of orbital procession described by (1.18) is the same as that described by (1.21) or (1.23), procession angle doesn't change under the transformation of radial coordinates.
And using background coordinates general relativity naturally becomes the gravitational theory on Minkowski flat background space-time, and can compare dynamic behavior with other gravitational theory.

Secondly, we decide internal exact solution of equation (1.4) in the background coordinate system With l as standard radial coordinate the exact interior solution of (1.4) is given by.

$$ds^2 = -\exp\left[C_2 + \int_l^{l_e} f(l)\left(1+\frac{\omega(l)}{l}\right)^{-1} dl\right] dt^2 + \left(1+\frac{G\omega(l)}{l}\right)^{-1} dl^2 + l^2(d\theta^2 + \sin^2\theta d\varphi^2) \quad (1.24)$$

Here $\omega(l) \equiv 4\pi\int_0^l \rho(l)l^2 dl$, $f(l) \equiv \frac{G}{l^2}\left[4\pi l^3 p(l) + \omega(l)\right]$, $l_e = l(r_e)$. Constant $C_2 = \ln[1-\frac{2GM}{l_e}]$ which

makes sure g_{00} is continual on the boundary of the celestial body. Equation (1.24) is prove follows.

As scalar $\rho=\rho(l)=\tilde{\rho}(r)$, $p=p(l)=\tilde{p}(r)$, the wave signs imply different form of function, and outside source both p and ρ vanish, $\rho = p = 0$ for $r > r_e$. For static spherical symmetry, in standard coordinate system the line element is written by $ds^2 \equiv -d\tau^2 = -B(l)dt^2 + A(l)dl^2 + l^2(d\theta^2 + \sin^2\theta d\varphi^2)$,

nonzero metric components $g_{00} = g_{tt} = -B(l),$ $g_{11} = g_{rr} = A(l),$ $g_{22} = g_{\theta\theta} = l^2,$ $g_{33} = g_{\varphi\varphi} = l^2\sin^2\theta,$ the other are zero; and $g^{00} = -\frac{1}{B}$, $g^{11} = \frac{1}{A}$, $g^{22} = \frac{1}{l^2}$, $g^{33} = \frac{1}{l^2\sin^2\theta}$, nonzero connection $\Gamma^1_{11} = \frac{A'}{2A}$ $\Gamma^0_{01} = \frac{B'}{2B},$ $\Gamma^2_{33} = -\sin\theta\cos\theta$, $\Gamma^3_{23} = \cot\theta,$ $\Gamma^1_{33} = -\frac{l}{A}\sin^2\theta,$

$\Gamma^2_{12} = \Gamma^3_{13} = \frac{1}{l},$ $\Gamma^1_{22} = -\frac{1}{2}g^{11}\frac{\partial g_{33}}{\partial l} = -\frac{l}{A}\sin^2\theta,$ $\Gamma^1_{00} = \frac{B'}{2A},$ where $A' \equiv \frac{dA}{dl}$ $B' \equiv \frac{dB}{dl}$. Nonzero Ricci tensor $R_{00} = -\frac{B''}{2A} + \frac{B'}{4A}(\frac{A'}{A} + \frac{B'}{B}) - \frac{B'}{lA'}$, $R_{22} = \frac{l}{2A}(-\frac{A'}{A} + \frac{B'}{B}) + \frac{1}{A} - 1$, $R_{11} = \frac{B''}{2B} - \frac{B'}{4B}(\frac{A'}{A} + \frac{B'}{B}) - \frac{A'}{lA}$,

$R_{33} = \sin^2\theta R_{22}$. On the other hand $T_{\mu\nu} = (\rho + p)U_\mu U_\nu + pg_{\mu\nu}$, $g^{\mu\nu}U_\mu U_\nu = -1$, $T = g^{\mu\nu}T_{\mu\nu} = 3p - \rho$,

and for the case of static spherical symmetry $p = p(l),$ $\rho = \rho(l),$ $U_0 = -\sqrt{B}$, $U_i = 0$, then $T_{00} - \frac{T}{2}g_{00} = \frac{B(3p+\rho)}{2}$, $T_{33} - \frac{T}{2}g_{33} = l^2\sin^2\theta\frac{(\rho - p)}{2}$, $T_{22} - \frac{T}{2}g_{22} = \frac{l^2(\rho - p)}{2}$, $T_{11} - \frac{T}{2}g_{11} = \frac{A(\rho - p)}{2}$.

Field equation (1.4) is equivalent to $R_{\mu\nu} = 4\pi G(T_{\mu\nu} - \frac{1}{2}Tg_{\mu\nu})$, we get the following three independent equations:

$$\begin{cases} R_{00} = -\frac{B''}{2A} + \frac{B'}{4A}(\frac{A'}{A} + \frac{B'}{B}) - \frac{B'}{lA'} = 2\pi G(\rho + 3p)B \\ R_{11} = \frac{B''}{2B} - \frac{B'}{4B}(\frac{A'}{A} + \frac{B'}{B}) - \frac{A'}{lA} = 2\pi G(\rho - p)A \\ R_{22} = \frac{l}{2A}(-\frac{A'}{A} + \frac{B'}{B}) + \frac{1}{A} - 1 = 2\pi G(\rho - p)l^2 \end{cases}$$

the other components are identities. Then $\frac{R_{00}}{2B} + \frac{R_{11}}{2A} + \frac{R_{22}}{l^2} = -\frac{1}{l^2} + \frac{1}{Al^2} - \frac{A'}{lA^2} = 4\pi G\rho$, namely $\left(\frac{l}{A}\right)' = 1 + 4\pi G\rho l^2$, and since $A(0)$ is limited, we infer $A(l) = \left(1 + \frac{G\omega(l)}{l}\right)^{-1}$, where $\omega(l) \equiv 4\pi \int_0^l \rho(l) l^2 dl$. On the other hand, the conserved law $T^{\nu}_{\mu;\nu} = 0$ gives $\frac{B'}{B} = -\frac{2p'}{\rho + p}$, then from $R_{22} = \frac{l}{2}(1 + \frac{G\omega(l)}{l})\left[\frac{G}{l^2}(l\omega' - \omega)(1 + G\omega)^{-1} - \frac{2p'}{\rho + p}\right] + (1 + \frac{G\omega}{l}) - 1 = 2\pi G(\rho - p)l^2$, after being simplified

$\frac{dp}{dl} = G(p + \rho)\left(2\pi l^3 p + \frac{\omega}{2}\right)\left(l^2 + lG\omega(l)\right)^{-1}$. And from $\frac{B'}{B} = -\frac{2p'}{\rho + p} = -2G\left(2\pi l^3 p + \frac{\omega}{2}\right)\left(l^2 + lG\omega(l)\right)^{-1}$, we obtain $B(l) = \exp\left[C_2 + \int_l^{l_e} f(l)\left(1 + \frac{\omega(l)}{l}\right)^{-1} dl\right]$, here $f(l) \equiv \frac{G}{l^2}\left[4\pi l^3 p(l) + \omega(l)\right]$, and constant $C_2 = \ln\left(1 - \frac{2GM}{l_e}\right)$ which makes sure $B(l)$ is continuous on the bound r_e. Note that the value of $l(r_e)$ on the bound is determined by the following (1.27).

In order to determine the solution in background coordinates, (1.19) is extended as inside source

$$\frac{dl}{dr} = \sqrt{1 + \frac{G\omega(l)}{l}} \exp\left(-G\int \frac{\rho}{\xi} dx'dy'dz'\right). \qquad (1.25)$$

Obvious line element (1.24) becomes

$$ds^2 = -\exp\left[C_2 + \int_l^{l_e} f(l)\left(1 + \frac{\omega(l)}{l}\right)^{-1} dl\right]dt^2 + \exp\left(-2G\int \frac{\rho}{\xi} dx'dy'dz'\right) dr^2 + l^2(d\theta^2 + \sin^2\theta d\varphi^2). \qquad (1.26)$$

Here $l = l(r)$ is a specific function of r, which is determined by equation (1.25). Line element (1.26) is just the exact solution looked for in background coordinate system $x^\mu = (x^0, x^1, x^2, x^3) = (t, r, \theta, \varphi)$. The solution of equation (1.25) satisfies initial condition $l(0) = 0$. In fact, because there is no acceleration tendency towards any direction at the center, dg_{00}/dr must be zero, and from (1.26) we have

$$0=\frac{dg_{00}}{dr}=\frac{dl}{dr}\frac{dg_{00}}{dl}=\frac{dl}{dr}f(l)\left(1+\frac{\omega(l)}{l}\right)^{-1}\exp\left[C_2+\int_l^{l_e}f(l)\left(1+\frac{\omega(l)}{l}\right)^{-1}dl\right],$$

which indicates $f(l)=0$ at the center, and so that $l=l(0)=0$ at the center. And if $\rho=const=\frac{3M}{4\pi r_e^3}$, then

$\int\frac{\rho}{\xi}dx'dy'dz'=\frac{3M}{2r_e}-\frac{M}{2r_e^3}r^2$, $\omega(l)=4\pi\int_0^l\rho(l)l^2dl=\frac{M}{r_e^3}l^3$, the solution of equation (1.25) is easily given by

$$\sqrt{\frac{r_e^3}{GM}}In\left(\sqrt{\frac{GM}{r_e^3}}l+\sqrt{1+\frac{GM}{r_e^3}l^2}\right)=\left[r+\frac{GM}{6r_e^3}r^3+\frac{1}{40}\left(\frac{GM}{r_e^3}\right)^2r^5+\cdots\right]\exp(-\frac{3GM}{2r_e}) \tag{1.27}$$

Though energy density ρ, generally speaking, isn't a constant, we may take its average value or piecewise integrate on r in practice for the convenience of calculation. As an important example, on the surface of the Sun $r=r_e=6.96\times10^8$ m, $M=1.99\times10^{30}$ kg, using (1.27), taking average value of ρ, we work out the surface's $l=l(r_e)=6.96\times10^8\text{ m}-1720\text{ m}$, which is highly equal to the sun's radius. And likewise, we can work out $l=6371km-0.00038km$ on the Earth's surface, and this almost equals the Earth's radius 6371km.

So far, using the continuity of $l=l(r)$ not only we can determine the constant C_1 but also can calculate the deflected angle of light line on the surface of the sun. For photon's propagation from (6) we have

$$0=ds^2=-\left(1-\frac{2GM}{l}\right)dt^2+\exp(-\frac{2GM}{r})dr^2+l^2\left(d\theta^2+\sin^2\theta d\varphi^2\right)$$

$$=-\left(1-\frac{2GM}{l}\right)dt^2+\left(1-\frac{2GM}{l}\right)^{-1}dl^2+\left(d\theta^2+\sin^2\theta d\varphi^2\right)l^2.$$

Similar to former calculation, the deflected angle is given by $\alpha=\frac{4MG}{l}=\frac{4MG}{l(r_e)}=1.78"$, which is more consistent with observational result ($1.89"$) compared with former theoretical value $\alpha=\frac{4MG}{r}=\frac{4MG}{r_e}=1.75"$. On the other hand, the conserved law gives

$$\frac{dp}{dl}=G(p+\rho)\left(2\pi l^3p+\frac{\omega}{2}\right)\left(l^2+lG\omega(l)\right)^{-1}. \tag{1.28}$$

On the boundary the gravity acceleration should be continual, according to (1.5), and using (1.19), (1.21), (1.25),

(1.26) we have $(\Gamma_{00}^1)_{r=r_e^+}=(\Gamma_{00}^1)_{r=r_e^-}$, that is, $(g^{11}\frac{dg_{00}}{dr})_{r=r_e^+}=(g^{11}\frac{dg_{00}}{dr})_{r=r_e^-}$, it follows that

$$\left[\frac{dl}{dr}\frac{d}{dl}\left(1-\frac{2GM}{l}\right)\right]_{r=r_e^+}=\left\{\frac{dl}{dr}\frac{d}{dl}\exp\left[C_2+\int_l^{l_e} f(l)\left(1+\frac{\omega(l)}{l}\right)^{-1}dl\right]\right\}_{r=r_e^-}$$

And after simplifying further, it becomes

$$[4\pi l_e^3 p+\omega(l_e)]\sqrt{l_e-2GM}=-2M\sqrt{l_e+G\omega(l_e)}\,, \tag{1.29}$$

which is the boundary condition p must satisfy, and the condition determines p negative within celestial body.

For general cases, inside source, gravitational field is still weak, $l=l(r)\approx r$, $2GM/r<<1$, and from (1.29) the boundary pressure $p\approx-\frac{3M}{4\pi r_e^3}=-\bar{\rho}$. $\bar{\rho}$ denotes average .

2. LOCAL EFFECT OF SPACE-TIME EXPANSION AND GALAXY FORMATION

In the early 20th century Hubble found that distant galaxies were going far away from us, and the farther galaxies were, the higher their recession speed was, this phenomenon was explained as universal expansion or space-time expansion. However, it is obviously not sensible only to understand space-time expansion for galaxies to leave far away from one another, that is to say, inside galaxies or in small scope there should also be corresponding response [13-25] which is the inevitable requirement of space-time's continuity. In fact, with scientific experiments and observations developed deeper and deeper, the effect of space-time expansion has already been found in small scope. For example, the earth is found going away from the sun, and the earth itself is growing too , the velocity of Milky Way arms is increasing namely faster and faster, after considering tidal effect the moon has still other motion to leave the earth, as well found a variety of spacecrafts to work to deviate the prediction of classic theory, and so on some problems current physics is not to able to explain.

2.1. Brief Overview of Newton Theory of Central Gravitational Field

So-called central motion refers to that a less object of mass m revolves round a bigger one mass M , and the bigger object may be thought stationary. For such central motion the track of object is cone curve, in the polar coordinate system (r,θ), the Newton's classical track equation is

$$r=\frac{L^2}{GMm^2(1+e\cos\varphi)} \tag{2.1}$$

Here $e=\sqrt{1+\frac{2El^2}{G^2M^2m^3}}$, stands for eccentricity of the cone curve, and L stands for angular momentum of revolving object, E stands for its mechanical energy, both L and E are conserved.

For $e<1$, $E=-\frac{GmM}{2a}$, the curve is ellipse, and a is the semi-major axis. And for $E=0$, $e=1$, the curve is parabola. For $E=\frac{GMm}{2a}$, $e>1$, the curve is hyperbola, a stands for the half distance between two vertexes. The differential equations of dynamics are

$$\frac{dr}{dt}=\pm\sqrt{\frac{2}{m}\left[E-V(r)-\frac{L^2}{2mr^2}\right]} \tag{2.2}$$

$$\frac{d\varphi}{dt}=\frac{L}{mr^2} \tag{2.3}$$

Here $V(r)=-\frac{GMm}{r}$ is the potential energy of revolving object. In Newton theory both m and M are constant. About equation (2.1), (2.2) and (2.3) readers may refer to any textbooks of theoretical mechanics

2.2. Generalize Newton theory to the expanding space-time

May as well take ellipse motion for example, classical Kepler law is

$$\frac{4\pi^2a^3}{T^2}=GM \tag{2.4}$$

T is the revolution period of object of mass m, namely the time the object revolves round the center across 2π angle to cost，and M is the mass of the central body，a is ellipse's semi-major axis.

Now consider the expansion of space-time, namely think M for variable with respect to time t and meets equation (1.11), and differentiating both sides of equation (2.4) we attain

$$\frac{da}{dt}=aH+\frac{2a}{3T}\frac{dT}{dt} \tag{2.5}$$

Here $H=\frac{dR}{Rdt}$ is just Hubble parameter and shows the speed of universal expansion. The last term of equation (2.5) stands for so-called tidal effect, which has nothing to do with universal expansion, and the term aH stands for the effect of universal expansion. In fact, as $a\to\infty$，dT becomes zero because equation（2.5) must return to the usual Hubble law under such extreme condition，therefore it is reasonable to explain the last term of equation (2.5) for tidal effect.

Equation (2.5) indicates that only considering space-time expansion the points on the ellipse go far away from the center and meet Hubble law, the ellipse becomes larger and larger with the speed of revolving object continuously increasing, however the period T is invariant.

extend the result to whole universe, the global picture of universal expansion turns up immediately, that is, not only space enlarges but also celestial bodies and galaxies theirselves enlarge meanwhile at the same proportion, but the periods of revolution or rotation keep invariant. The such situation of universal expansion is similar to we are looking towards the sky at night to use a magnifying glass: all things including the space magnify simultaneously in the same size. Thus we say that space-time expansion possess convex lens effect, which is the fundamental mechanism of formation and evolution of galaxies or celestial bodies. Obviously Hubble parameter $H(t)$ plays the role of magnification. Why the period of rotation of celestial body is also invariant as revolution can so be understood: any celestial body can divide into innumerable small parts and every part can be looked as a object revolving round the common axis, this is to say, look rotation for the integration of revolutions.

So far we say that the local effect of global space-time expansion is actually the dynamics and kinematics of formation and evolution of galaxies or celestial bodies.

The convex lens effect of space-time expansion requires the angular speed $\omega=\omega(\varphi,t)$ of revolving object round a central body to meet

$$\omega(\varphi,t_1)=\omega(\varphi+2n\pi,t_2) \tag{2.6}$$

which makes sure its revolving period invariant, namely dT=0.

Referring to equation (1) and considering space-time expansion the track equation of revolving object is

$$r = r(\varphi, t) = \frac{L^2}{GMm^2(1 + e\cos\varphi)} \tag{2.7}$$

Notice that now, L, m, M are all functions with respect to time t, and m, M meet equation (1.11), $L = m\omega r^2$. Easily prove that eccentricity $e = \frac{c}{a} = \sqrt{1 + \frac{2EL^2}{G^2M^2m^3}}$ is still invariant. In fact, write the semi-major axis $a = k_1R(t)$, the semi-minor axis $b = k_2R(t)$, k_1, k_2 are two constants, we have

$$e = \frac{c}{a} = \frac{\sqrt{a^2 - b^2}}{a} = \frac{\sqrt{k_1^2 - k_2^2}}{k_1} = \text{constant}$$

However the difference between long axis and short axis increases with time because of $a - b = (k_1 - k_2)R(t)$.

And if time t takes different values, equation (2.7) represents a series of concentric ellipses. And from equation (2.7) we have

$$\frac{r(\varphi, t_1)}{r(\varphi + 2n\pi, t_2)} = \frac{R(t_1)}{R(t_2)} \tag{2.8}$$

correspondingly the orbit speed $v = v(\theta, t)$ of revolving object meets

$$\frac{\mathrm{v}(\varphi, t_1)}{\mathrm{v}(\varphi + 2n\pi, t_2)} = \frac{R(t_1)}{R(t_2)} \tag{2.9}$$

where $n = 0 \pm 1, \pm 2 \cdots$. And further we have $\frac{\partial \mathrm{v}(\varphi, t)}{\partial t} = \mathrm{v}(\varphi, t)H(t)$, which indicates the revolving object has the mean tangential acceleration, this is just the effect of space-time expansion but not exist real tangential force. This result demonstrates the recent observation that the revolving speed of the Milky Way arm is becoming faster and faster, and obviously not understood by conventional knowledge.

Equation (2.6) ~ equation (2.9) are enough qualified to describe various motions in central gravitational field and not only fit to deal with elliptic motion.

Example1: refer to Figure 3. Assume time t_1 object is at point D, speed is v_D, and if not considering space-time expansion its track is the interior small ellipse , now decide the position and speed of time t_2 under considering space-time expansion.

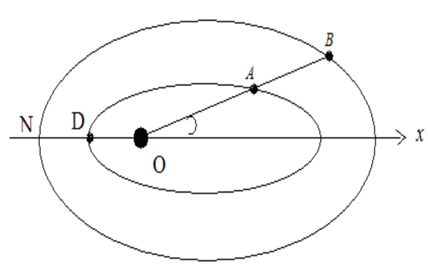

Fig3. *Sketch map of a moving particle on different ellipses at different time*

Solving: at time t_2 point D arrives at point N to meet Hubble law，the real position of revolving object at time t_2 is sure on the ellipse that passes point N, may as well think at point B, and join point O (center body position) to point B, then point A is the position that object should arrive at according to classical theory at time t_2, the speed v_A is easily solved using classical theory. Since $ON = OD\frac{R(t_2)}{R(t_1)}$, $OB = OA\frac{R(t_2)}{R(t_1)}$, here OD, v_D is already known. From equation (2.2) we have $t_2 - t_1 = \int_{OD}^{OA} \frac{dr}{\sqrt{\frac{2}{m}\left[E + \frac{GMm}{r} - \frac{l^2}{2mr^2}\right]}}$, so OA can be decided, notice that here M , m , l take the values of time t_1 , treated as constants in the course of integral. And according to $\frac{1}{2}mv_D{}^2 - \frac{GMm}{r_D} = \frac{1}{2}mv_A{}^2 - \frac{GMm}{r_A}$, we can decide v_A , here $r_D = OD$. Finally using $v_B = v_A \frac{R(t_2)}{R(t_1)}$, we can decide the real speed v_B at time t_2.

Example2. Investigate the secular change of distance of perigee or apogee of the moon due to space-time expansion, and referring to the data from tidal rhythmites study the mean speed of lunar recession over the past 450myr, as well the the change of length of sidereal day.

Solving: today, the distance of perigee of the moon is $d_1 = 36.3\times10^4 km$, and according to Hubble law in a year the distance increases by $\Delta d_1 = H_0 d_1 \Delta t = 26.13mm$, here Δt takes 1 year, and on the other hand, the distance of apogee is $d_2 = 40.6\times10^4 km$, for alike reason the distance of apogee increases in a year by $\Delta d_2 = H_0 d_2 \Delta t = 29.23mm$, thus the increase of the difference of distances of apogee and perigee due to space-time expansion is $\Delta d_2 - \Delta d_1 = 3.1mm$ a year, and observational value is around 6mm, which means tide only make the increase by 2.9mm a year. Correspondingly the semi-major axis increases by $\frac{\Delta d_2 + \Delta d_2}{2} = 27.68mm$, and the observational is around 3.8cm (Lunar laser Ranging data), which means tide make the semi-major axis increase only 1.03cm a year today. If attribute all the change of 3.8cm to tidal effect, through careful calculation James Williams found the change of eccentricity of lunar orbit 3 times smaller than observation .

The above result show that the influence of the tide is quite small to lunar orbit and the effect of space-time expansion is the main dynamic for universe to evolve. And only when the scale of celestial body is not too small compared with the distance between two celestial bodies the effect of tides is distinct.

Now calculate the average speed of lunar recession over the past 450myr. Tidal rhythmites tell us that during the Ordovician (begin 485myr ago and end 443myr ago) a year had 382.7 sidereal days and 13.81 sidereal months [23]. Since the period of revolution of the earth does not change neglecting the tides of sun-earth system, that is to say the length of a year keeps invariant, so the length of a sidereal month was then

$\frac{365.24 \times 24hr}{13.81} = 634.7hr$, and today is $\frac{365.24 \times 24hr}{13.37} = 655.6hr$. To use $\frac{4\pi^2 a^3}{T^2} = GM_e$ and $R(t) = A\sin\left(t\sqrt{\frac{4\pi G\rho}{3}}\right)$, universal observed density $\rho = 3.1\times10^{-24} kg/m^3$, for two moments t_0, t_1

$$\frac{a^3(t_0)}{T^2(t_0)} \div \frac{a^3(t_1)}{T^2(t_1)} = \frac{M_e(t_0)}{M_e(t_1)} = \frac{R^3(t_0)}{R^3(t_1)} \qquad (2.10)$$

And may as well take $t_0 = 1.37\times10^{10} yr$, $t_1 = (1.37 - 0.045)\times10^{10} yr$, $T(t_1) = 634.7hr$,

$T(t_0) = 655.6hr$, $a(t_0) = 38.4\times10^4 km$, from (13) we work out $a(t_1) = 36.27\times10^4 km$, which differs from the result 375000km of not considering equation (1.11). Thus the even speed of the increase of lunar semi-major axis over the past 450 myr is now

$$\frac{\Delta a}{\Delta t} = \frac{(38.4 - 36.27)\times10^9 cm}{4.5\times10^8 yr} = 4.7cm/yr \qquad (2.11)$$

Which indicates the past tidal action was stronger than today's that. And on the other hand to use the tidal formula $a^{11/2}\frac{da}{dt} = const$ [23] we may roughly estimate the recession speed during the Ordovician

$$\frac{da(t_1)}{dt} = \left(\frac{a_0}{a_1}\right)^{11/2}\frac{da(t_0)}{dt} = \left(\frac{38.4}{36.27}\right)^{11/2}\times3.8cm/yr = 5.2cm/yr \qquad (2.12)$$

These results indicate that the past recession speed of the moon was higher than today.

Notice that not considering the change of the earth's mass, the corresponding mean recession speed is

$\frac{(38.4 - 37.5)\times10^9 cm}{4.5\times10^8 yr} = 2cm/yr$ which shows the past tidal action was lower than today's tide and is obviously not compatible with tidal principle-------the farther distance, the smaller effect of tides.

Finally, estimate the change rate of length of sidereal day today.

During the Ordovician the length of sidereal day is $\frac{365.24\times24hr}{382.7} = 22.9hr$, and today is 23.9 hours.

Thus the mean change rate of the length of sidereal day over the past 450myr is

$$\frac{\Delta T_e}{\Delta t} = \frac{(23.9 - 22.9)\times3600s}{4.5\times10^8 yr} = 0.8ms/cy \qquad (2.13)$$

Since space-time expansion does not change a variety of periods of motions, the change of length of day originate still from tidal interaction, and for tidal interaction angular momentum is conserved and therefore the following empirical equation (2.14) derived by R. G. Williamson to use tidal theory is still valid [18]

$$\frac{d\Omega}{dt} = (49\pm3)\frac{dn}{dt} \qquad (2.14)$$

Where Ω is angular speed of rotation of the earth, and n is the angular speed of revolution of the moon. To use equation (2.5) the change rate of length of sidereal month is today

$$\frac{dT_m}{dt}=\frac{3T_m}{2a}(\frac{da}{dt}-Ha)=\frac{3\times 655.6\times 3600\times 1.03s}{2\times 38.4\times 10^9\,yr}=9.4\text{ms/yr}$$

And using $\frac{dT_e}{T_e^2dt}=(49\pm 3)\frac{dT_m}{T_m^2dt}$ the changing rate of length of sidereal day is today calculated as

$$\frac{dT_e}{dt}=(0.61\pm 0.05)ms/cy \tag{2.15}$$

This result is smaller than the average value of 0.8ms/cy, and therefore is reasonable and verify that the past tidal action is stronger than today's that. And other some works conclude that, according to eclipse records over 2700 years, the current change rate of day length is $(1.7\pm 0.05)ms/cy$, which is obviously higher than the average value of 0.8ms/cy and therefore is unreasonable. Obviously the past eclipse records were not reliable enough. Note that since the past distance between the moon and the earth was smaller than today's that the past effect of tide must be stronger than today's that, in a word the past recession speed or the past changing rate of day length must be faster than today's that. So far, so-called anomaly of lunar orbit clear up entirely.

2.3. link and exact description of general relativity, illustrate the course of galaxy formation

Next, we prove that equation (2.6) ~ equation (2.9) are the approximations of general relativity under low speed and weak field

Birkhoff 's theorem indicates that in the gravitational field of spherical symmetry, no matter how the gravitational source behaves, as long as the spherical symmetry keeps up the line element is the same form

$$ds^2=-(1-\frac{2Gk}{l})dt^2+\frac{1}{1-\frac{2Gk}{l}}dl^2+l^2(d\theta^2+\sin^2\theta d\varphi^2) \tag{2.16}$$

This is to say, with t,l,θ,φ as independent variables equation (2.16) is a solution of vacuum field equation $R_{\mu\nu}$ =0. When the mass of central body changes and meets equation (1.11) the gravitational field is still described by (2.16), in other words equation (2.16) not only describes static-source gravitational field but also variable-source gravitational field, only requirement is the spherical symmetry keeps up. In the metric field described by (2.16), for a revolving object, in t,l,θ,φ coordinate system, metric

$g_{00}=-1+\frac{2Gk}{l}$, $g_{11}=\left(1-\frac{2Gk}{l}\right)^{-1}$, $g_{22}=l^2$, $g_{33}=l^2\sin^2\theta$, $g_{\mu\nu}=0(\mu\neq\nu)$, and nonzero connection

$\Gamma^1_{11}=\frac{1}{2}g^{1\rho}(\frac{\partial g_{\rho 1}}{\partial x^1}+\frac{\partial g_{\rho 1}}{\partial x^1}-\frac{\partial g_{11}}{\partial x^\rho})=-\frac{Gk}{(1-2Gk/l)r^2}$, $\Gamma^0_{01}=\frac{Gk}{(1-2Gk/l)l^2}$, $\Gamma^1_{00}=\frac{(1-2Gk/l)Gk}{l^2}$,

$\Gamma^2_{12}=\frac{1}{l}$, $\Gamma^1_{22}=\Gamma^1_{33}=-(1-\frac{2Gk}{l})l$, and geodesic $0=\frac{d^2\varphi}{d\tau^2}+\Gamma^3_{\alpha\beta}\frac{dx^\alpha}{d\tau}\frac{dx^\beta}{d\tau}=\frac{d^2\varphi}{d\tau^2}+\frac{2}{l}\frac{dl}{d\tau}\frac{d\varphi}{d\tau}$, its solution is $\frac{d\varphi}{d\tau}l^2=const=h$, and another geodesic $0=\frac{d^2t}{d\tau^2}+\Gamma^0_{\alpha\beta}\frac{dx^\alpha}{d\tau}\frac{dx^\beta}{d\tau}=\frac{d^2t}{d\tau^2}+\frac{1}{g_{00}}\frac{\partial g_{00}}{\partial l}\frac{dl}{d\tau}\frac{d\varphi}{d\tau}$,

its solution is $\frac{dt}{d\tau}(1-\frac{2GK}{l})=const=a$, and combining with (2.16) we obtain the moving object's trajectory

$$\frac{h^2}{l^4}\left(\frac{dl}{d\varphi}\right)^2+\frac{h^2}{l^2}=(a^2-1)+\frac{2Gk}{l}+\frac{2Gkh^2}{l^3} \quad (2.17)$$

a and h are two integral constants . Readers may refer to any a textbook of general relativity about equation (2.17). In the distance namely in weak field after neglecting $\frac{2Gkh^2}{l^3}$, equation (2.17) has the approximate solution

$$l=\frac{h^2}{Gk(1-e\cos\varphi)} \quad (2.18)$$

Compared with (2.6) and (2.7), for specific central body M (t) we conclude that constant $k=\frac{M(t)}{R^3(t)}$.

And now we need investigate the behavior of motion of the object in background coordinate system , so we introduce coordinate transformation $t=t$, $l=\frac{l'}{R(t)}=\frac{l'(r)}{R(t)}$, and in consideration of (1.20) function $l'=l'(r)$ is required to meet

$$\sqrt{l'(l'-2Gk)}+2Gk\ln\left(\sqrt{l'}+\sqrt{l'-2Gk}\right)=C_1+r-Gk\ln r-\frac{1}{2r}G^2k^2+\frac{1}{12r^2}G^3k^3+\cdots$$

Such transformation makes sure that if space-time expansion is not considered, namely *set R* (t) =1, all will return to Schwarzschild static metric field.

And in view of above discussion, in the distance or in weak field we have $l'(r)\approx r$, here equation (2.18) becomes equation (2.7), namely

$$r=\frac{R^4(t)h^2}{GM(t)(1-e\cos\varphi)}=\frac{L^2}{GM(t)m^2(t)(1-e\cos\varphi)} \quad (2.19)$$

Obviously different function M (t) corresponds to different constant k.. And next we have

$$h=\frac{d\varphi}{d\tau}l^2=\frac{d\varphi}{d\tau}\frac{r^2}{R^2(t)}=\frac{dt}{d\tau}\frac{d\varphi}{dt}\frac{r^2}{R^2(t)}=\frac{\omega ar^2}{R^2(t)(1-2Gk/l)}$$

which means (2.6) to hold in weak field..

So far we have already proved that equation (2.6) ~ equation (2.9) are the approximations of general relativity under low speed and weak field, that is to say, planet orbits expand in accordance with Hubble law is

a result of general relativity.

And substituting $l=\frac{r}{R(t)}$, $k=\frac{M(t)}{R^3(t)}$ into (2.17) obtains the more rigorous trajectory equation in background coordinates

$$\frac{R^2h^2}{r^4}\left(\frac{dr}{d\varphi}\right)^2-\frac{R\ h^2}{r^3}\frac{dr}{d\varphi}\frac{dR}{d\varphi}+\frac{h^2}{r^2}(\frac{dR}{d\varphi})^2+\frac{R^2h^2}{r^2}=(a^2-1)+\frac{2GM(t)}{rR^2}+\frac{2GMh^2}{r^3} \quad (2.20)$$

which is a gradually magnifying and rotating spiral line, the points on the line go away from the center body and meet Hubble law.

When (2.20) is used to a spiral galaxy, the spiral arms rotate and meanwhile stretch outward, the galaxy becomes bigger and bigger, that is to say , galaxy formation lies in gradual growth but not come from the existent matter gathers. See the following Figure 4.

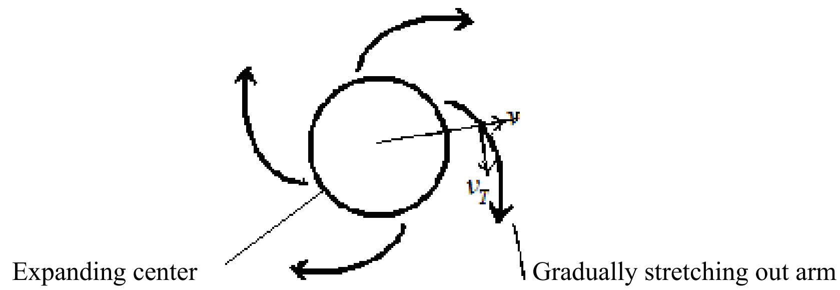

Fig4. *Sketch map of formation and evolution of spiral arms*

Randomly select three planes of different time in space, and take three equal squares on the three planes respectively, the black spots represent the galaxies cut by the planes, Figure 5 is the diagrammatic sketch, shows that galaxies grow up while space enlarges, earlier time is, smaller and denser galaxies are. Notice that the earlier stage means the time around the beginning of recent a circulation of expansion and contraction, the beginning of expansion is just the end of the previous contraction. The uniformity of matter distribution in big scope today is just the magnification of the uniformity of early matter distribution in small scope. For universe to finish a course of expansion and contraction calls a circulation, in the beginning of expansion or the end of contract all galaxy's mass is zero. And today universe is in the stage of expansion, so far the expansion has already been lasting for $1.37\times10^{10}\,yr$, which is in accordance with the age of big bang. Universal expansion is often likened to a balloon being blown up, on which the ink spots don't enlarge and only the nearby space enlarges, in reality should say ink spots also enlarge simultaneously.

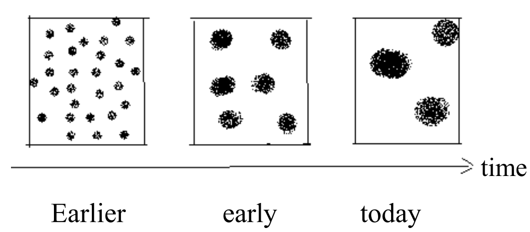

Fig5. *Sketch of size and distribution of galaxies in different time*

The galaxies seen today is smaller when their distance is farther, this shows that light speed is limited and meanwhile indicates early galaxies are smaller than ones of today. See the following Figure 6

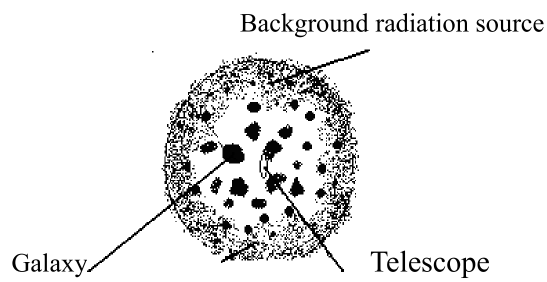

Fig6. *The actual picture of galaxies seen by today's telescope*

In a word**,** anomaly of planet orbit including the increase of astronomical unit is the effect of universal expansion, galaxies or celestial bodies come from gradual growth but not the assemblage of existent material after big bang. While space enlarges celestial bodies or galaxies theirselves also enlarge at the same proportion, new matter continuously generates inside celestial bodies or galaxies. Conventional conserved laws, such as energy or mass conserved laws, angular momentum conserved law as well as momentum conserved law are the approximation of small time and small scope, and in big time and big scope they are no longer strictly valid.

The thought matter continuously creates is great and impossible to overthrow simply, instead it must return to science. So-called failure of F. Hoyle's theory lies in his wrong modification to Einstein's field equation and don't mean the idea of continuous creation of matter unreasonable.

2.4. Quantum mechanism of matter continuously creates in celestial bodies, the sun neutrino puzzle, statistical analysis of elemental abundance

$P=-\rho$ tells us that the negative pressure in celestial bodies is equivalent to a negative energy field, it is the constant excitation of the negative energy field that creates material particles, in the same time the negative energy field increase a portion of equal-value negative energy, this guarantees total energy in universe, namely the sum of negative energy and positive energy, is zero all the time.

And since matter in universe is neutral, the incipient material particles must be neutrons, soon some neutrons decay into protons, electrons and anti-neutrinos. And next usual nuclear reactions happen, the initial several nuclear reactions are

$$n \to p+\bar{\nu}+e^- \qquad n+p \to D+\gamma \qquad {}^1\mathrm{H} + {}^1\mathrm{H} \to {}^2D+\nu+e^+$$

$$ {}^2D+{}^1\mathrm{H} \to {}^3\mathrm{H}e+\gamma \qquad {}^3\mathrm{H}e+{}^3\mathrm{H}e \to {}^4\mathrm{H}e+2\,{}^1\mathrm{H} \qquad {}^3\mathrm{H}e+{}^3\mathrm{H}e \to {}^7\mathrm{B}e+\gamma$$

$$e^- + {}^7\mathrm{B}e \to {}^7Li+\nu+\gamma \qquad {}^1\mathrm{H}+{}^7\mathrm{B}e \to {}^8\mathrm{B}+\gamma \qquad {}^8\mathrm{B} \to {}^8\mathrm{B}e+e^+ +\nu$$

It is noticeable that there exists reaction $\nu+\bar{\nu} \to 2\gamma$, and it is the reaction that explains why the quantity of measured neutrino is lower than the theoretical value, this is so-called the sun neutrino puzzle. Most neutrinos annihilate with anti-neutrinos to become photons, thus the measured value is lower than theoretical value. In fact, the anti-neutrinos measured on the earth come still from the sun but not the earth itself, because it is impossible for many radioactive elements to exist in the interior of the earth. It is also wrong to understand neutrino puzzle for the conversion among neutrinos, namely, electric neutrinos convert into μ neutrinos, because we were not finding equal-number μ neutrinos.

The negative energy field within celestial bodies offers much energy to the celestial bodies, only minor energy radiates out in the form of photons and major energy stays as material in celestial bodies, for example the sun is offered energy a year today according to equation (1.11)

$$\Delta E = \Delta m_0 c^2 = 3H_0 m_0 c^2 \Delta t = 3.9\times 10^{37} J$$

and observations show that the sun radiates energy $10^{30} J$ a year today, accounted for only 2/100000000 of the total offered energy.

Elemental abundance in celestial bodies should be decided by their temperature. For a celestial body of temperature T, we may as well treat all atoms in it as a open thermodynamic system, whose giant distribution function according to quantum statistics is given by

$$\rho = \exp(-\Psi - \sum_{i=1}^{k} \alpha_i N_i - \beta E)$$

Where N_i denotes the number of atoms of i-th kind element. And let m_i denote its mass, the total energy $E=\sum_{i=1}^{k} N_i m_i$, then the average value of atom number of element of j-th kind reads

$$\bar{N}_j = \frac{\sum_{N_1=0}^{\infty}\sum_{N_2}^{\infty}\dots\sum_{N_k}^{\infty}\exp N_j\left[-\psi-\sum_{i=1}^{k}N_i(\alpha_i+\beta m_i)\right]}{\sum_{N_1=0}^{\infty}\sum_{N_2}^{\infty}\dots\sum_{N_k}^{\infty}\exp\left[-\psi-\sum_{i=1}^{k}N_i(\alpha_i+\beta m_i)\right]} = -\frac{1}{m_j}\frac{\partial}{\partial\beta} In\sum_{N_j=0}^{\infty}\exp(-\alpha_j-\beta m_j)N_j$$

$$= \frac{1}{m_j}\frac{\partial}{\partial\beta} In(1-e^{-\alpha_j-\beta m_j}) = \frac{1}{\exp(\alpha_j+\beta m_j)-1} = \frac{1}{\exp\frac{m_j-\mu_j}{kT}-1}$$

Here μ_i amounts to the chemical potential of the group, T is the temperature of the celestial body, namely average kinetic energy of all atoms, k is Boltzmann constant. From above relation we have for arbitrary two elements A and B

$$\frac{\bar{N}_A}{\bar{N}_B} = \frac{\exp\frac{m_B c^2-\mu_B}{kT}-1}{\exp\frac{m_A c^2-\mu_A}{kT}-1} \qquad (2.21)$$

which decides the abundance of elements in a celestial body. Observations of astronomy show that element abundance is different in different celestial bodies, which is consistent with (2.21). Observations of astronomy show that the abundance of elements is in accordance seen from large scope, which implies both temperature and chemical potential are uniform seen from large scope. Observations of astronomy show that all elements in other celestial bodies can also be found out on the earth, which implies that the origin of various elements is in the same way

2.5. Evolution of temperature, brightness and surface's gas pressure of celestial bodies

according to the principle that space, celestial bodies and galaxies together expand at the same size, radius r_e of a celestial body will increase with expansion of space and meet $r_e \propto R(t)$, that is to say, $dr_e = Hr_e dt$, $r_e = k\exp\int Hdt$, and similarly, for arbitrary two moments t_1, t_2 there exists

$$\frac{r_e(t_1)}{r_e(t_2)} = \frac{R(t_1)}{R(t_2)}$$

For example one year today the radius of the earth increases by

$$\Delta r_{e0} = H_0 r_{e0}\Delta t = 0.7\times10^{-10}/yr\times6400km\times1yr = 0.45mm$$

which is in accordance with recent observations [20]. 2.7 billion years ago its radius was about 5185km. It is easily derived that gravity acceleration of surface of a star at random two moments meets

$$\frac{g(t_1)}{g(t_2)} = \frac{m(t_1)}{r^2(t_1)} \div \frac{m(t_1)}{r^2(t_2)} = \frac{R(t_1)}{R(t_2)} \qquad (2.22)$$

Further the atmosphere pressure of the surface changes to meet

$$\frac{p_t(t_1)}{p_t(t_2)} = \rho g(t_1)h(t_1)/\rho g(t_2)h(t_2) = \frac{R^2(t_1)}{R^2(t_2)} \qquad (2.23)$$

Here use p_t to expresses common pressure so as to distinguish the pressure as gravitational source, and $h(t)$ expresses height of surface gas of celestial body, and according to the principle of equal-proportion expansion in different time atmosphere height evolves to meet

$$\frac{h(t_1)}{h(t_2)} = \frac{R(t_1)}{R(t_2)}.$$

As application of (2.23), the radio of surface's gas pressure of the earth is, 2.7 billion years ago to today

$$\frac{p_t(t_1)}{p_t(t_0)} = \frac{R^2(t_1)}{R^2(t_0)} \approx (\frac{t_1}{t_0})^2 = (\frac{137-27}{137})^2 = 64\%$$

In the center we have

$$p_t = \int_0^{r_e} \frac{G\rho m(r)}{r^2} dr = \frac{2\pi G\rho^2 r_e^2}{3} \propto R^2(t) \qquad (2.23)$$

If matter around the center meets ideal gas law $p_t = \dfrac{\rho}{\mu} RT$, the temperature changes to meet

$$\frac{T(t_1)}{T(t_2)} = \frac{R^2(t_1)}{R^2(t_2)} \qquad (2.24)$$

Equal-density expansion of celestial bodies means the temperature of celestial bodies must constantly rise so as to resist the continuous rising gravitation.

But the temperature of surface is our interest, because it has direct contact with observation. For the sake we consider mass-luminosity relation, the following are several conventional empirical formula

$$\frac{L}{L_\odot} = 2.3\left(\frac{M}{M_\odot}\right)^{2.3}, \quad M < 0.43 M_\odot$$

$$\frac{L}{L_\odot} = \left(\frac{M}{M_\odot}\right)^{4}, \quad 0.43 M_\odot < M < 2M_\odot$$

$$\frac{L}{L_\odot} = 1.5\left(\frac{M}{M_\odot}\right)^{3.5}, \quad 2M_\odot < M < 20 M_\odot$$

The above relations show the horizontal connexion among celestial bodies, and now we use them to research the vertical comparison of celestial bodies theirselves

Note that $r_e \propto R(t)$, $d_p \propto R(t)$, d_p is the proper distance from the star to us, and σ, ρ are invariant all along, $M = \dfrac{4}{3}\pi\rho r_e^3$, absolute luminosity

$$L = 4\pi r_e^2 \cdot \sigma T_e^4 = 4\pi r_e^2 \cdot l_e = 4\pi d_p^2 \cdot \sigma T_p^4 = 4\pi d_p^2 \cdot l_p$$

l_e is absolute brightness, l_p is vision brightness. We have the following relations about brightness and surface's temperature of the same body

$$\frac{l_e(t_1)}{l_e(t_2)}=\frac{l_p(t_1)}{l_p(t_2)}=\frac{T_e^4(t_1)}{T_e^4(t_2)}=\frac{T_p^{\ 4}(t_1)}{T_p^{\ 4}(t_2)}=\frac{R^{4.9}(t_1)}{R^{4.9}(t_2)}\ ,\quad M<0.43M_{\odot}$$

$$\frac{l_e(t_1)}{l_e(t_2)}=\frac{l_p(t_1)}{l_p(t_2)}=\frac{T_e^4(t_1)}{T_e^4(t_2)}=\frac{T_p^{\ 4}(t_1)}{T_p^{\ 4}(t_2)}=\frac{R^{10}(t_1)}{R^{10}(t_2)}\ ,\quad 0.43M_{\odot}<M<2M_{\odot}$$

$$\frac{l_e(t_1)}{l_e(t_2)}=\frac{l_p(t_1)}{l_p(t_2)}=\frac{T_e^4(t_1)}{T_e^4(t_2)}=\frac{T_p^{\ 4}(t_1)}{T_p^{\ 4}(t_2)}=\frac{R^{8.5}(t_1)}{R^{8.5}(t_2)}\ ,\quad 2M_{\odot}<M<20M_{\odot}$$

$$\frac{l_e(t_1)}{l_e(t_2)}=\frac{l_p(t_1)}{l_p(t_2)}=\frac{T_e^4(t_1)}{T_e^4(t_2)}=\frac{T_p^{\ 4}(t_1)}{T_p^{\ 4}(t_2)}=\frac{R(t_1)}{R(t_2)}\ ,\quad 20M_{\odot}<M$$

Note that $L_{\odot}$, $M_{\odot}$ are respectively absolute luminosity and mass of the sun today, may be viewed as constants. As application, the ratio of the sun's brightness is, 2.7 billion years ago to today

$$\frac{l_p(t_1)}{l_p(t_0)}=\frac{R^{10}(t_1)}{R^{10}(t_0)}\approx(\frac{t_1}{t_0})^{10}=(\frac{137-27}{137})^{10}=11\%$$

which indicates that the sun is brighter and brighter. Again, if the temperature of surface of the earth is 298K ($25^{\circ}C$) today, then it was, 2.4 billion years ago,

$$T_e(t_1)=T_e(t_0)\frac{R^{1.2}(t_1)}{R^{1.2}(t_0)}\approx 298\times(\frac{t_1}{t_0})^{1.2}=298\times(\frac{137-24}{137})^{1.2}=234K \qquad (2.25)$$

namely $-38^{\circ}C$, is a world of ice. The same way, we can work out temperature of the surface of the earth was $0^{\circ}C$ 0.9 billion years ago, which means life began 0.9 billion years ago.

Recent an in-depth study [26] showed that the earth was a hockey 2.4 billion years ago, temperature of the equator was $-40^{\circ}C$, this conclusion is highly in accordance with present theory. And recent another in-depth study [27] showed that the atmosphere pressure 2.7 billion years ago was half of today's that, the brightness of the sun 2.7 billions years ago was 15% of today's that, highly conformable with our result.

Continuous creation of matter makes celestial bodies brighter and brighter, temperature is higher higher, and universe was dark ten billion years ago and so-called big bang fireball don't exist at all. Observations show that the sun indeed is becoming brighter and brighter, and actually it is a strained interpretation for conventional theory to explain the fact for so-called gravitational collapse. In fact, since think that the sun's mass is smaller and smaller because of unceasing burning, its interior gravitation should be smaller and smaller and thus collapse trend should be weaker and weaker, the sun becomes impossibly brighter and brighter, and more serious question is that there is not controllable mechanism why the burning is neither fast nor slow. A deep fact implied strong from mass-luminosity relation is that the bigger mass, the higher is its luminosity, and as a result, if solar mass is becoming smaller and smaller due to burning its luminosity should decrease gradually and impossibly becomes brighter and brighter.

in a word in the framework of big bang theory the temperature of matter in universe can only be getting lower and lower and the sun impossibly becomes brighter and brighter and the earth will not also become hotter and hotter. The world given by big bang theory is actually a gradually dying and declining world and on contrary, the world based on the continuous creation of matter is a energetic and exuberant world.

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