Journal of Modern Physics, 2018, 9, 1441-1447
http://www.scirp.org/journal/jmp
ISSN Online: 2153-120X
ISSN Print: 2153-1196

Gravitational Energy and No Big Bang Starts the Universe

Walter Petry

Mathematical Institute, University of Duesseldorf, Duesseldorf, Germany
Email: wpetry@meduse.de

How to cite this paper: Petry, W. (2018) Gravitational Energy and No Big Bang Starts the Universe. *Journal of Modern Physics*, **9**, 1441-1447.
https://doi.org/10.4236/jmp.2018.97088

Received: May 31, 2018
Accepted: June 22, 2018
Published: June 25, 2018

Abstract

Gravitation in flat space-time is described as field and studied in several articles. In addition to the flat space-time metric a quadratic form formally similar to that of general relativity defines the proper-time. The field equations for the gravitational field are non-linear differential equations of second order in divergence form and have as source the total energy-momentum tensor (inclusive that of gravitation). The total energy-momentum is conserved. It implies the equations of motion for matter in this field. The application of the theory gives for weak fields to measurable accuracy the same results as general relativity. The results of cosmological models are quite different from those of general relativity. The beginning of the universe starts from uniformly distributed gravitational energy without matter and radiation which is generated in the course of time. The solution is given in the pseudo-Euclidean metric, *i.e.* space is flat and non-expanding. There are non-singular solutions, *i.e.* no big bang. The redshift is a gravitational effect and not a Doppler effect. Gravitation is explained as field with attractive property and the condensed gravitational field converts to matter, radiation, etc. in the universe whereas the total energy is conserved. There is no contraction and no expansion of the universe.

Keywords

Gravitation, Flat Space-Time, Cosmology, No Singularity, No Big Bang, Non-Expanding Universe, No Doppler Effect

1. Introduction

The most accepted theory of gravitation is general relativity (GR) of Einstein. The reason for this is the good agreement of the results of the theory with experiments for weak fields where only low order approximations of GR are needed. GR gives for homogeneous, isotropic, cosmological models a singularity of the solution in the beginning with infinite density of matter, the so-called big bang. This demands the expansion of space with cosmic inflation after the singularity to get agreement with the experimentally verified flat space.

In this article, the theory of gravitation in flat space-time (GFST) is applied to cosmological models. It gives for weak gravitational fields the same results as GR to measurable accuracy (see [1]). Let us study by the use of GFST homogeneous, isotropic, cosmological models in the pseudo-Euclidean metric, *i.e.* space is flat. In the beginning of the universe all the energy is gravitational energy, *i.e.* no matter. In the course of time gravitational energy is converted to matter without contraction or expansion of space. There are non-singular, cosmological models, *i.e.* no big bang. The result is a non-stationary universe with conservation of the total energy. The redshift is a gravitational effect and not a Doppler effect. The solution is non-singular, *i.e.* matter is always finite and no big bang exists. The interpretation of the result in an expanding universe is possible because of the non-singular solution and the general covariance of GFST.

2. Homogeneous, Isotropic, Cosmological Model

Let us summarize the results of homogeneous, isotropic, cosmological models of GFST. GFST is studied in the book [1] and in many articles, e.g. [2] [3] [4] and [5] where homogeneous, isotropic, cosmological models are given, too. GFST was first considered in article [6] where the metric is the pseudo-Euclidean geometry. The theory was applied to cosmology yielding non-singular solutions (see article [7]). A non-expanding universe was already considered in article [7].

We follow along the lines of article [5] by the use of the pseudo-Euclidean metric, *i.e.*

$$(\mathrm{d}s)^2 = -\eta_{ij}\mathrm{d}x^i\mathrm{d}x^j \tag{2.1}$$

with $(\eta_{ij}) = (1,1,1,-1)$ and the Cartesian coordinates $(x^i) = (x^1, x^2, x^3, ct)$. The pseudo-Euclidean metric is the standard geometry for physical problems and implied by astrophysical observation of flat space. The universe is described by the use of the gravitational field

$$g_{ij} = a^2(t),\ (i = j = 1,2,3)$$

$$g_{ij} = -1/h(t),\ (i = j = 4)$$

$$g_{ij} = 0\ (i \neq j) \tag{2.2a}$$

with the proper-time τ:

$$(c\mathrm{d}\tau)^2 = -g_{ij}\mathrm{d}x^i\mathrm{d}x^j \tag{2.2b}$$

Let (u^i) be the four-velocity with

$$u^i = 0\ (i = 1,2,3)$$

which implies by (2.1) and (2.2)

$$\left(u^i\right)=\left(0,0,0,c\sqrt{h}\right). \tag{2.3}$$

The matter tensor is a perfect fluid with pressure p and density ρ and

$$p=p_m+p_r,\ \ \rho=\rho_m+\rho_r \tag{2.4a}$$

where m and r denote matter and radiation. The equations of state are

$$p_m=0,\ \ p_r=\frac{1}{3}\rho_r \tag{2.4b}$$

Let $t_0=0$ be the present time and assume the initial conditions at present:

$$a(0)=h(0)=1,\ \dot{a}(0)=H_0,\ \dot{h}(0)=\dot{h}_0,$$
$$\rho_m(0)=\rho_{m0},\ \ \rho_r(0)=\rho_{r0}, \tag{2.5}$$

where H_0 is the Hubble constant, $\dot{h}_0$ is a constant which doesn't appear by GR and ρ_{m0} and ρ_{r0} denote the present densities of matter and radiation of the universe. It follows under the assumption that matter and radiation do not interact

$$\rho_m=\rho_{m0}\big/\sqrt{h},\ \ \rho_r=3p_r=\rho_{r0}\big/\left(a\sqrt{h}\right). \tag{2.6}$$

GFST gives two field equations for a and h and the conservation of the total energy. It follows by suitable combinations of these equations and integration by the use of the initial conditions (2.5) (see e.g. [1] [2])

$$a^3\sqrt{h}=2\kappa c^4\lambda t^2+\varphi_0 t+1 \tag{2.7}$$

where

$$\kappa=4\pi k/c^4,\ \ \varphi_0=3H_0\left(1+\frac{1}{6}\frac{\dot{h}_0}{H_0}\right) \tag{2.8}$$

and λc^2 is the total conserved energy. Let Ω_m, Ω_r and Ω_Λ be the standard definitions of the density parameters of matter, radiation and vacuum energy and put

$$\Omega_m K_0=\Omega_m+\Omega_r+\Omega_\Lambda-1. \tag{2.9}$$

The field equations of gravitation give two differential equations of order two and one equation by the use of the conservation of the total energy. Suitable combinations of these three differential equations imply by longer calculations (see article [2]) the differential equation

$$\left(\frac{\dot{a}}{a}\right)^2=\frac{H_0^2}{\left(2\kappa c^4\lambda t^2+\varphi_0 t+1\right)^2}\left(-\Omega_m K_0+\Omega_r a^2+\Omega_m a^3+\Omega_\Lambda a^6\right) \tag{2.10a}$$

with the initial condition

$$a(0)=1. \tag{2.10b}$$

The solution of (2.10) together with (2.7) describes a homogeneous, isotropic, cosmological model by the use of GFST. Furthermore, it holds

$$\frac{8\kappa c^4\lambda}{H_0^2}-\left(\frac{\varphi_0}{H_0}\right)^2=12\Omega_m K_0 . \tag{2.11}$$

A necessary and sufficient condition to avoid singularities of the solution of (2.10) is (see e.g. [1] [2])

$$K_0>0 \tag{2.12}$$

which gives

$$2\kappa c^4\lambda t^2+\varphi_0 t+1>0$$

for all $t\in\mathbb{R}$. Hence, condition (2.12) implies a non-singular solution for all $t\in\mathbb{R}$, *i.e.* we get a non-singular, cosmological model.

It exists $t_1<t_0=0$ such that

$$\dot{a}(t_1)=0 . \tag{2.13}$$

Put $a_1=a(t_1)$ then it follows from (2.10a) with $t=t_1$

$$\Omega_r a_1^2+\Omega_m a_1^3+\Omega_\Lambda a_1^6=\Omega_m K_0 . \tag{2.14}$$

It holds for all $t\in\mathbb{R}$

$$a(t)\geq a_1>0 . \tag{2.15}$$

Let us assume

$$a_1\ll a(0)=1 , \tag{2.16}$$

then we get by the use of (2.14)

$$K_0\ll 1. \tag{2.17}$$

It follows from (2.9) that the sum of the density parameters is a little bit greater than one

The presently assumed density parameter of matter is

$$\Omega_m\approx 0.3 .$$

It follows from (2.9) and (2.17)

$$\Omega_\Lambda\approx 0.7$$

with the assumption that the sum of these density parameters is a little bit greater than one, *i.e.* we get the same approximation as by GR but with different assumptions, namely flat space by GR and no singularity by GFST.

We get from (2.10) and (2.7) that $a(t)$ starts for $t=-\infty$ from a small positive value, decreases to the small positive value a_1 and then increases for all $t\in\mathbb{R}$ whereas $h(t)$ starts from infinity, decreases to a positive value and then increases (see e.g. [1] [2]).

The differential equation (2.10a) is rewritten by the use of (2.7) in the form

$$\left(\frac{\dot{a}}{a}\right)^2=H_0^2\frac{1}{h}\left(-\frac{\Omega_m K_0}{a^6}+\frac{\Omega_r}{a^4}+\frac{\Omega_m}{a^3}+\Omega_\Lambda\right). \tag{2.18}$$

The proper-time $\tilde{\tau}$ from the beginning of the universe till time t is

$$\tilde{\tau}(t)=\int_{-\infty}^{t}1\Big/\sqrt{h(s)}\,\mathrm{d}s . \tag{2.19}$$

The time t starts from $-\infty$ whereas the proper-time $\tilde{\tau}(t)$ starts from zero and then increases till $\tilde{\tau}(0)$, *i.e.* the age of the universe. Hence, the age of the universe is finite measured with proper-time and the age is infinite measured system time given by the pseudo-Euclidean metric. Therefore, a time before the proper-time of the age of the universe makes no sense.

The differential Equation (2.18) is rewritten by the introduction of the proper-time $\tilde{\tau}$:

$$\left(\frac{1}{a}\frac{\mathrm{d}a}{\mathrm{d}\tilde{\tau}}\right)^2 = H_0^2\left(-\frac{\Omega_m K_0}{a^6} + \frac{\Omega_r}{a^4} + \frac{\Omega_m}{a^3} + \Omega_\Lambda\right). \tag{2.20}$$

This differential equation is identical with that of GR with zero curvature by virtue of (2.17) for $t > t_1$ and a sufficiently large. Therefore, the result for the universe of a flat space of GR for sufficiently large a, *i.e.* sufficiently large away from the singularity is nearly identical with that of GFST enough time after time t_1. It worth to mention that the beginning of the universe by GFST and by GR are quite different. The cosmological model of GFST contains in the beginning of the universe only gravitational energy and no matter. In the course of time matter, radiation and vacuum energy is generated where the total energy is conserved. Gravitational energy is partly converted to matter and other energies. There is no contraction and no expansion of space by virtue of the pseudo-Euclidean metric (2.1) implying a flat space. A flat space is also received if we use (2.2) as metric as by GR.

It is worth to mention that the condition (2.12) is important to avoid a singularity. GR gives (2.20) with $K_0 = 0$ which implies the singularity, *i.e.* the big bang. The detailed calculations of these results can be found in the book [1].

$\tilde{\tau}$ is the time measured with atomic clocks but for mathematical calculations it is sometimes useful to introduce the absolute time t' by

$$\mathrm{d}t' = \frac{1}{(a(t))\sqrt{h(t)}}\mathrm{d}t = 1/a(t)\,\mathrm{d}\tilde{\tau} \tag{2.21}$$

This gives

$$(c\,\mathrm{d}\tau)^2 = -a^2\left[\lfloor \mathrm{d}x \rfloor^2 - (c\,\mathrm{d}t')^2\right]. \tag{2.22}$$

where $\lfloor . \rfloor$ denotes the Euclidean norm. Light velocity is equal to vacuum light velocity.

The differential Equation (2.18) is rewritten by the use of the absolute time t' of (2.21) in the form

$$\left(\frac{\mathrm{d}a}{\mathrm{d}t'}\right)^2 = \frac{H_0^2}{a^2}\left(-\Omega_m K_0 + \Omega_r a^2 + \Omega_m a^3 + \Omega_\Lambda a^6\right). \tag{2.23}$$

The energy of a photon emitted at time t'_e from an object at distance r from the observer is by virtue of (2.21),

$$\mathrm{d}\tilde{\tau} = a(t'_e)\,\mathrm{d}t'$$

This gives for the energy of the photon

$$E \sim -g_{44} \frac{\mathrm{d}t'}{\mathrm{d}\tilde{\tau}} = a(t'_e) E_0 \tag{2.24}$$

where E_0 is the emitted energy of the same atom at time t'_0. The energy of the photon which moves to the observer in the universe is by virtue of (2.22) constant (see e.g. [1]). Then, the corresponding frequency is

$$\nu = a(t'_e)\nu_0$$

where ν is the received frequency by the observer and ν_0 the frequency emitted from the same atom at the observer. The redshift is by definition the difference of the observed wavelength and the standard one divided through the standard one. Hence, the redshift satisfies the relation (expressed by the corresponding frequencies)

$$z = \nu_0/\nu - 1 = 1/a(t'_e) - 1. \tag{2.25}$$

Light emitted at distance r at time t'_e and received at $r = 0$ at time t'_0 satisfies by the constant velocity of light the relation

$$r = c(t'_0 - t'_e).$$

This implies by Taylor expansion of $a(t'_e)$ of (2.25)

$$z = H_0 \frac{r}{c} + \left(1 + \frac{1}{2}\frac{1}{H_0^2}\frac{\mathrm{d}^2 a(t'_e)}{\mathrm{d}t_e'^2}\right)\left(H_0 \frac{r}{c}\right)^2.$$

Differentiation of equation (2.23) gives by neglecting small expressions

$$\frac{\mathrm{d}^2 a(t'_e)}{\mathrm{d}t_e'^2} = H_0^2\left(1 - \frac{1}{2}\Omega_m + \Omega_\Lambda\right) \approx H_0^2\left(2 - \frac{3}{2}\Omega_m\right).$$

Hence, the redshift has the form

$$z \approx H_0 \frac{r}{c} + \frac{3}{4}\Omega_m \left(H_0 \frac{r}{c}\right)^2 \tag{2.26}$$

The detailed calculation of this result can be found in the book [1]. The redshift is already derived in article [6] without use of the Doppler effect. This cosmological model was already studied in article [2] where as well as the interpretation of a bounce is used and the interpretation of a non-expanding universe is mentioned.

3. Conclusion

GFST is a covariant theory of gravitation in flat space-time. It gives for weak gravitational fields to measurable accuracy the same results as GR. But there are also differences to the results of GR for strong gravitational fields, e.g. in the beginning of the universe The gravitational field is described by non-linear differential equations of order two in divergence form where the source is the total energy-momentum tensor including that of gravitational field. The conservation of the total energy-momentum tensor gives the equations of motion of matter. The theory is generally covariant. The space of the universe is flat. The universe starts with uniformly distributed gravitational energy in the whole space, *i.e.* no matter and no other forms of energy. In the course of time matter, radiation and vacuum energy are created where the total energy of the universe is conserved. Neither expansion nor contraction of space takes place. Singularities don't arise, *i.e.* all physical quantities are finite and big bang doesn't exist. The redshift of spectral lines of distant objects is a gravitational effect by virtue of the time dependent gravitational field. The age of the universe is finite measured with proper-time but infinite measured with system time which is given by the pseudo-Euclidean metric.

References

[1] Petry, W. (2014) A Theory of Gravitation in Flat Space-Time. Science Publishing Group.

[2] Petry, W. (2013) *Journal Modern Physics*, **4**, 20-25. https://doi.org/10.4236/jmp.2013.47A1003

[3] Petry, W. (2015) *Journal Modern Physics*, **6**, 1085-1094. https://doi.org/10.4236/jmp.2015.68113

[4] Petry, W. (2016) *Journal Modern Physics*, **7**, 1492-1439. https://doi.org/10.4236/jmp.2016.712135

[5] Petry, W. (2017) *Journal Applied Mathematics and Physics*, **5**, 882-872.

[6] Petry, W. (1979) *General Relativity and Gravitation*, **10**, 599-608. https://doi.org/10.1007/BF00757210

[7] Petry, W. (1981) *General Relativity and Gravitation*, **13**, 1057-1071. https://doi.org/10.1007/BF00756365

[8] Petry, W. (2007) Is the Universe Really Expanding? arXiv:0705.4359.