A Hydro-Dynamical Model for Gravity

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Abstract*: A hydro-dynamical model for gravity by using an analogy with the attraction of spherical sources in incompressible fluids is proposed. Information regarding a photon-like particle called graviton is taken using an author's previous paper [6]. The substance and radiation interaction due to emission of gravitons takes place via an energy field made of the emitted gravitons and filling the entire universe. The energy distribution is considered uniform at the universe scale. A consequence of the proposed model is the increasing of the universal "constant" of gravity, as a function of the age of universe.*

Key Words: *graviton emission, "fluid of gravitons", age of universe, energy formulation.*

1. INTRODUCTION

There are many theories of gravity [1-4]. Among them, the general relativity, gives an interpretation on geometrical reasons, but does not use particles as carriers of interaction, unlike quantum mechanics. On one hand we remember that Newton and Euler thought that ether could drive bodies toward each other.

In the following, one tries to combine the existence of a particle usually called graviton, but acting by means of an intermediate field also made of gravitons. This is possible by using a hydro-dynamical analogy.

Unlike the case of electrical sources, the interaction between spherical sources in an incompressible fluid [5] leads to forces of attraction for sources of the same sign and rejection in case of different signs. Then an attempt could be done to find a model of gravity forces, always of attraction.

2. MODEL PRESENTATION

Let Q_1, Q_2 be the volume rates of two sources of fluid located in two points as seen in Fig 1. The hydro-dynamical force of interaction, F_H, is oriented along the direction which connects the two sources and has the expression [5]:

$$F_H = \frac{\rho\, Q_1\, Q_2}{4\,\pi\, R_{12}^2}\,; \rho = const., \tag{1}$$

where ρ is the mass density of the fluid which fills the space and R_{12} the distance between sources.

A source is positive /negative if it injects / absorbs fluid (of the same density). The force is attraction for sources of the same sign and rejection in case of different signs. On the other hand, the Newton law of the universal attraction of two bodies is:

$$F_N = f_N \frac{m_1\, m_2}{R_{12}^2}, \tag{2}$$

where m_1, m_2 are the body masses and $f_N = 6.67E - 11 m^3 / kg / \sec^2$ is the Newton constant of universal attraction.

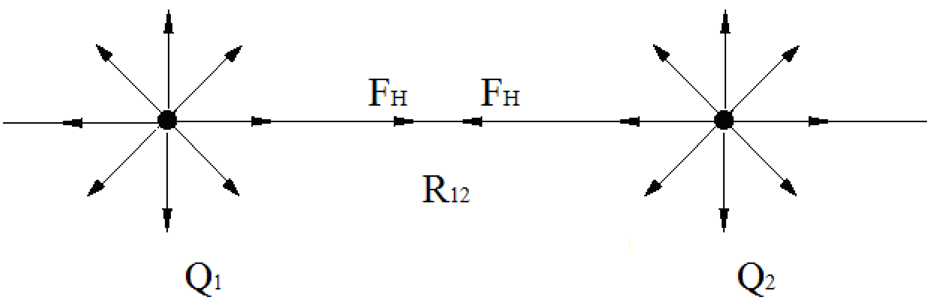

Fig. 1 Spherical sources in incompressible fluid

One introduces now the total energy, *E (Joule)*, using the special relativity formulas [10]:

$$E = m\,c^2;\; m = m_0 / \sqrt{1 - V^2 / c^2}, \tag{3}$$

m_0 being the mass at rest, *V* the body velocity and *c* the speed of light in vacuum.

As one can speak about vacuum, we consider as reference system the vacuum itself, and the total energy is considered with respect to this system of reference.

The Newton formula then becomes:

$$F_N = f_{NE}(t_u) \frac{E_1\, E_2}{R_{12}^2};\; f_{NE}(t_u) = f_N(t_u) / c^4\,, \tag{4}$$

$f_{NE}(t_u)$ being the new coefficient (not constant!) of universal attraction in the formulation considering energies instead of masses.

This coefficient is a function of the age of universe, t_u, considered from the moment of BIG BANG (or , better said, BIG FLASH [6]).

The proposed model has the following basic assumptions:

a$_0$) although at a smaller scale the energy repartition in universe is not uniform (galaxies, stars, planets) at the global scale this repartition is uniform enough to consider a constant energy density equal to its average value at a time t_u. Indeed, the radius of universe is, for example, at $t_{u\,act}$ of the order of 10^{10} light years, whereas the maximum size of our galaxy is of the order of 10^5 light years; Although the general relativity leads to a modified time near the compact masses and energies, this represents a local time but at the universe scale, an average time is to be considered; one takes here the above time t_u ;

a_1) the analogue of a hydro-dynamical source is any amount of energy (larger then the energy of a graviton, which is defined bellow) emitting gravitons due to:

1) a higher energy level and
2) the expansion of universe;

a_2) the graviton is a photon-like particle having a wave length, $\lambda_g(t_u)$, of the order of the radius of universe:

$$\lambda_g(t_u) = C_{\lambda g} R_u(t_u);\; C_{\lambda g} = const., \tag{5}$$

$C_{\lambda g}$ being a coefficient of proportionality and $R_u(t_u)$ the radius of universe. Accordingly the energy of graviton, $E_g(t_u)$, is

$$E_g(t_u) = h\,c / \lambda_g\,, \tag{6}$$

h being the Planck constant (h = 6.626E-34 Joule.sec).

By using the uncertainty principle of Heisenberg, to the energy of a graviton corresponds a time interval of uncertainty Δt_g, given by:

$$\Delta t_g \approx \frac{h}{4\pi E_g(t_u)} = \frac{C_{\lambda g}}{4\pi}\frac{R_u(t_u)}{c}. \tag{7}$$

For $C_{\lambda g} \approx 4\pi$, the time interval of uncertainty Δt_g, has the order of magnitude of the age of universe, i.e. a graviton could appear at any time, thus hard to be detected. On the other hand the particle temperature of a graviton is very small (of the order of E-29 Kelvin today), too small to be measured.

Further one transforms the formula (1) of the hydro-dynamical force, first by introducing the mass rate m' and the energy rate E', as follows:

$$m' = \rho Q;\; E' = m'c^2;\; F_H = \frac{m_1' m_2'}{4\pi\rho R_{12}^2} = \frac{E_1' E_2'}{4\pi\rho R_{12}^2 c^2}. \tag{8}$$

Now one considers that any amount of energy (other than gravitons) injects/absorbs a rate of “fluid of gravitons” of the mass density,

$$\rho = \rho_{g\,u};\; \rho_{E\,g\,u} = \rho_{g\,u} c^2\,, \tag{9}$$

where $\rho_{E\,g\,u}$ is the density of energy for free gravitons in universe:

$$\rho_{E\,g\,u}(t_u) = \frac{3\,E_{g\,u}(t_u)}{4\pi R_u^3(t_u)}. \tag{9a}$$

In the above formula (9a), $E_{g\,u}(t_u)$ is the total energy of the fluid of (free) gravitons filling the universe.

Then one assumes that any amount of energy, *E*, (other than gravitons) is emitting/ absorbing gravitons proportionally i.e.:

$$E' = \theta_g(t_u)\, E\,, \tag{10}$$

$\theta_g(t_u)$ being the intensity (1/sec) of emission/ absorption.

The expression of the "hydro-dynamical" force (2) finally becomes:

$$F_H = \frac{\theta_g^2(t_u)\, E_1\, E_2}{4\,\pi\,\rho_{E\,g\,u}(t_u)\, c^2 R_{12}^2}\,. \tag{11}$$

Therefore one obtains attraction both for emission ($\theta_g(t_u) > 0$), and absorption ($\theta_g(t_u) < 0$). In the following we consider the case of emission ($\theta_g(t_u) > 0$), as the universe is expanding.

By equating the Newton force (4) and the "hydro-dynamical" force (10), one obtains:

$$\theta_g^2(t_u) = 4\,\pi\, c^2 \rho_{E\,g\,u}(t_u)\; f_{N\,E}(t_u)\,. \tag{12}$$

3. THE EQUATION FOR THE ENERGY OF EMITTED GRAVITONS

One considers an initial moment, t_{u0}, of the universe evolution from the initial explosion. This moment is taken from our model of universe [6] and corresponds to the moment when the substance was created from radiation under the form of neutrons. The main features of this model of an early universe are given in Table 1.

The radii of universe in light years (*l.ys*) are given for the initial and actual time. The actual background

Table 1. Radii of universe and background temperature

R_{u0} (*l. ys.*)	R_{uact} (*l. ys.*)	T_G (K)	E_{U0} / E_{ne0}
5.091 E5	18.30 E9	3.4679	2.308 E80

temperature is T_G. E_{U0} = 3.467916 *E70 Joule* is the total energy of universe and E_{ne0} = 1.507437*E-10 Joule* is the energy of neutron at rest.

The number of neutrons at t_{u0} = 5.091*E5* years is close to 2.308 *E80* neutrons. One considers that at substance occurrence an equal number of gravitons were released. Then the "fluid of gravitons" at t_{u0} has the energy $E_{g\,u\,0}$, given by (see eq.(5)):

$$E_{g\,u\,0} = 2.308E80\,\frac{h\,c}{R_{u0}} = 9.52608E33\,Joule;\; (C_{\lambda g} = 4\,\pi)\,. \tag{13a}$$

The particle temperature of graviton at time t_{u0} is:

$$T_{g\,u\,0} = h\,c\,/\,R_{u0}\,k_B = 2.9898E - 24\,K\,, \tag{13b}$$

k_B being the Boltzmann constant.

Other information regarding the mass of the universe is useful [7; 8; 10] but does not provide a starting moment and energy of the “fluid of gravitons” for our model.

A differential equation for the increasing average energy of the “fluid of gravitons”, $E_{g\,u}$, can be written under the form:

$$\frac{dE_{g\,u}}{d\tau} = t_{u0}\theta_g(\tau)\left(E_{U\,0} - E_{g\,u}(\tau)\right);\ \tau = t_u / t_{u0}\,, \tag{14}$$

where the dimensionless time τ was introduced.

Besides the equation (12) one more equation for $\theta_g(\tau)$ can be written. To this aim a connection with the expansion of the universe which is controlled by gravity will be used.

One calculates the time derivative of the universe volume taking into account that the universe frontier is moving at the speed of light. This derivative divided by the total energy $E_{U\,0}$ has the expression:

$$\frac{d}{d\tau}\left(\frac{4\pi R_u^3}{3E_{U\,0}}\right) = \frac{4\pi c R_u^2}{E_{U\,0}}\ \left[\frac{m^3}{J\sec}\right];\ (R_u = c\,t_u). \tag{15}$$

We shall connect the above expression with the intensity of emission of gravitons, $\theta_g(\tau)$, as follows:

$$\frac{\theta_g(\tau)}{\theta_{Egu}(\tau)} = \chi(\tau)\frac{4\pi c R_u^2}{E_{U\,0}}\ \left[\frac{m^3}{J\sec}\right];\ \chi(\tau) = \chi_0\,\tau^{\alpha}\,,(\chi_0\,;\alpha, const.) \tag{16}$$

$\chi(\tau)$ being an adjusting dimensionless factor.

As a test, if the connection above between the gravity and the expansion of universe is adequate, the constants χ_0, α shall be small numbers.

By replacing the density $\rho_{Egu}(\tau)$ from (9) in (16), one obtains:

$$\theta_g(\tau) = \frac{3\chi_0\,c\,\tau^{\alpha-1}E_{gu}}{E_{U\,0}\,R_{u\,0}}, \tag{17}$$

and the eq. (14) becomes:

$$\frac{d\,E_{gu}}{d\,\tau} = \frac{3\chi_0\,c\,\tau^{\alpha-1}}{E_{U\,0}}\left(E_{U\,0} - E_{gu}\right)E_{gu} \tag{18}$$

The equation (18) has an analytical solution, given bellow:

$$\ln\left(\frac{E_{gu}\left(E_{U\,0} - E_{gu0}\right)}{E_{gu0}\left(E_{U\,0} - E_{gu}\right)}\right) = \frac{3\chi_0\,(\tau^{\alpha} - 1)}{\alpha}, \tag{19}$$

where the condition at the initial time ($\tau = 1; E_{g\,u} = E_{gu0}$) is satisfied.

As one can see from (19), for:

$$\alpha > 0, \tau \to \infty, E_{g\,u} \to E_{U0}\,, \tag{19a}$$

i.e. in time all the energy of universe could be transformed in gravitons if no other factors intervene.

The increasing speed of the energy, $E_{g\,u}$, $\dfrac{d\,E_{gu}}{d\,\tau}$ has a maximum at $\tau_{\max} = 1.267\tau_{act}$, 23.1861*E9* years after the initial singularity, i.e. about 5 billion years from now on. The energy of the "fluid of gravitons" is (at its maximum speed of amplification):

$$E_{g\,u\max} = 1.6482E780 = 0.47373E_{U0}\,,(\tau_{\max} = 1.267\tau_{act})\,. \tag{19b}$$

Now one uses the equations (12) and (17) to express the universal coefficient of attraction, $f_{N\,E}(\tau)$, under the form:

$$f_{N\,E}(\tau) = 3\chi_0\,E_{gu}\,R_{u0}\,\tau^{2\alpha+1}\,/\,E_{U\,0}^{2}\,. \tag{20}$$

Because the actual value of the gravity constant, denoted by $f_{N\,E\,act}$, is known one obtains an expression for the exponent α :

$$\alpha = \frac{1}{\ln(\tau_{act})}\ln\left(\frac{E_{U0}\sqrt{f_{N\,E\,act}}}{\chi_0\sqrt{3\,R_{u0}\,\tau_{act}\,E_{gu\,act}}}\right);\ \tau_{act} = 3.595E4\,. \tag{21}$$

The actual value of the dimensionless time, τ_{act}, was calculated using the value from Table 1, whereas the energy $E_{gu\,act}$ must satisfy the equation (19) for $\tau = \tau_{act}$:

$$\ln\left(\frac{E_{gu\,act}\left(E_{U\,0} - E_{gu0}\right)}{E_{gu0}\left(E_{U\,0} - E_{gu\,act}\right)}\right) = \frac{3\chi_0\,(\tau_{act}^{\alpha} - 1)}{\alpha\,E_{U\,0}}\,. \tag{22}$$

If the adjusting constant χ_0 is chosen, then the unknowns $\alpha, E_{gu\,act}$ can be calculated.

3.1 Calculations. Some Results and Interpretation

The main parameters of the model are calculated by using the above relations and presented in Table 2, for $\chi_0 = 1$, and Table 3, for $\chi_0 = 2$.

Table 2.
($f_{N\,E\,act}$ = 8.235*E*–45*m /Joule;* τ_{act} = 3.595*E4; $E_{g\,u\,0}$* = 9.5261*E*33 *Joule;* χ_0 = *1;* α = 0.157436)

τ/τ_{act}	E_{gu}	E_{gu}/E_{U0}	$f_{NE}(\tau)/f_{NEact}$	θ_g	$\rho_{Egu}(\tau)$	$10^{-6}t_u(ys)$
2.782*E-5*	9.5261*E*33	2.7380*E*-37	1.3808 *E* -41	1.7055*E*-58	2.0358*E*-32	0.5091
0.50	2.4889*E*64	7.1536 *E*-7	1.4174 *E* -5	1.1592*E*-31	9.1617*E*-15	0.915*E*4
1- 1/18.3	2.9785*E*68	0.00856	0.39195	8.1113*E*-28	1.6222*E*-11	1.730E4
1	7.05797*E*68	0.02029	1	1.8332*E*-27	3.2476*E*-11	1.830*E*4
1+1/18.3	1.5853*E*69	0.04556	2.4138	3.9451*E*-27	6.2311*E*-11	1.930*E*4
1.2057	*E* 70	0.2874	18.1192	2.2186*E*-26	2.6252*E*-10	2.2878*E*4
1.4262	3 *E* 70	0.8623	67.7905	5.6561*E*-26	4.7584E-10	2.6099*E*4

Table 3.
($f_{NE\,act}$ = 8.235*E*–45*m /Joule; τ_{act}* = 3.595*E*4; $E_{g\,u\,0}$ = 9.5261*E*33 *Joule; χ_0 = 2;* α = 0.046841)

τ/τ_{act}	E_{gu}	E_{gu}/E_{U0}	$f_{NE}(\tau)/f_{NEact}$	θ_g	$\rho_{Egu}(\tau)$	$10^{-6}t_u(ys)$
2.782*E*-5	9.5261E33	2.7380E-37	5.5233E-41	3.4111E-58	2.0358E-32	0.5091
0.50	2.35776E66	6.7768E-5	6.15151E-4	7.4328E-30	8.6791E-13	0.915E4
1-1/18.3	1.05925E69	0.030446	1/1.80293	1.8196E-27	5.7690E-11	1.730E4
1	1.79593E69	0.051619	1	2.9423E-27	8.2636E-11	1.830E4
1+1/18.3	2.95255E69	0.084086	1.72657	3.9454E-27	1.1475E-10	1.930E4

One can see that the adjusting parameters χ_0, α can be maintained within reasonable limits. For $\chi_0 = 1$, after (18.3E9 - 0.5091E6) years from the considered initial time, the energy of the field of gravitons is increased up to 0.02029E_{U0}, but the speed of graviton formation becomes faster and after one billion years ((1+1/18.31) τ_{act}) only this energy is more than double: 0.04556E_{U0} (see Table 2).

The universal coefficient of attraction, $f_{NE}(\tau)$, has increased about 10^{41} times in (18.3E9 - 0.5091E6) years from the initial time; however this represents a rate of only 1.005154 per 10^6 years, for $\chi_0 = 1$.

During the next billion years the increasing of $f_{NE}(\tau)$ is 2.4138 times of the actual value and during the next million years this amplification is 1.00088 times. If the angular momentum of our planet is constant, then its distance to sun is inverse to $f_{NE}(\tau)$, decreasing in the same ratio.

Then if the Sun radiation is not modified for some time interval of a billion years, for example, the flux energy from some will increase with a power of two of the distance diminution having a dramatic impact on biosphere.

As regards the density of energy, $\rho_{Egu}(\tau)$, increasing, it has a rate of 1.00273 per 10^6 years, for $\chi_0 = 1$ (Table 2); then the “fluid of gravitons” can be considered incompressible. Similar conclusions result for $\chi_0 = 2$ (Table 3).

3.2 The Gravitational Radiation

A few remarks can be done with respect to the gravitational energy. Because according to the proposed model any amount of energy (except gravitons themselves) is emitting gravitons one can speak of gravitational radiation.

As we know this radiation was not detected yet [8] and one expects it could be put in evidence in the neighborhood of big bodies with very high density of energy. A radiation of energy could exist even from black holes [9] and we assume that a part of it is represented by the gravity emission according to our model.

One can calculate the gravitational radiation by using the proposed model via the coefficient of the emission intensity $\theta_g(\tau)$. In Table 4 one presents several values for the Sun and Earth. The thermal flux of energy at the Sun surface is 6.3*E*7 Watt/sq.m, therefore 1.16054*E6* times the graviton radiation, the last one being difficult to detect. Because the particle temperature of graviton is very small (see(13-b)), the pressure of the gravitational flux, Φ_{gf}, could be an easier parameter to measure, one writes:

$$p_{gf} = 2\Phi_{gf} / c. \tag{23}$$

This pressure is given in Table 4.

Table 4. Data for Sun and Earth ($\chi_0 = 1$)

Object	Mass (kg)/ Energy(J)	Radius (m)	Therm.flux (Watt/sq.m)	Gravit.flux (Watt/sq.m)	Pres.of grav. rad. (barr)	Thermal intens, sec^{-1}
Sun	2.0*E*30/ 1.8 *E*47	6.955 *E* 8	6.3*E7*	54.2849	3.6190*E*-12	2.1275*E*-21
Earth	5.972 *E*24/ 5.3748 *E*41	6.371 *E* 3	0.408*E* 3	1.9317	1.2878*E*-13	3.8720*E*-25

As regards the thermal flux of energy reflected by the earth surface, considering an albedo equal to 0.3, and the distance to the Sun of 150 million km. is only 211.2 times the graviton radiation and could be detected within the total radiation of the earth surface. Its corresponding pressure is also given.

4. CONCLUSIONS

A hydro-dynamical model of gravity was proposed introducing a possible particle carrier called graviton. However the gravity force is acting via an intermediate “fluid of gravitons” filling the whole universe.

In addition, one assigns to any amount of energy the property of emission/absorption of gravitons, in both cases resulting a force of attraction unlike the electrical interaction.

The graviton is considered a photon-like particle its wave length being of the order of magnitude of the radius of universe at a given age. As a consequence, the graviton is hard to be detected.

One selects the case of graviton emission as taking place in an expanding universe. The emission is due to: 1) a higher energy level in comparison with graviton; 2) to the expansion of universe.

By hydro-dynamical analogy the attraction results as un unequal distribution of the momentum of the emitted gravitons.

A differential equation for the energy of the “fluid of gravitons” is written and solved analytically. The coefficient of the universal attraction is no more constant but depends on the age of the universe.

The model is applied starting from an initial time, t_{u0}, selected by using a model of an early universe previously given by author [6]. This time corresponds to the substance formation under the form of neutrons.

By assigning a graviton to any formed neutron one obtains an initial value for the energy of the “fluid of gravitons”. The emission of gravitons is connected with the expansions of the universe via an adjusting term depending on the age of the universe and containing two parameters: α and χ_0.

The first one, α, is determined by using the actual value of the universal coefficient of attraction and the solution of the model differential equation.

For the other parameter, χ_0, two reasonable values are selected for comparison. More information, although difficult to obtain, because of the very large time intervals necessary for observation and measurements could sustain the proposed model. The model offers a global and average image of the gravity in universe.

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