The informational model – gravity

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Abstract In a number of our arXiv papers it was rigorously shown that Matter in our Universe – and Universe as a whole - are some informational systems (structures), which exist as uninterruptedly transforming [practically] infinitesimal sub-sets of the absolutely infinite and fundamental set "Information". The conception enables to suggest a reasonable physical ("informational") model that is based on the conjecture that Matter is some analogue of computer (more correct – some analogue of a [huge] number of mutually weakly connected automata). The conjecture, in turn, allows introducing in the model the basic logical elements that constitute the material structures (e.g., particles) and support the informational exchange - i.e. the forces - between the structures. The model yet now makes clearer a number of basic problems in physics; and, besides, enables to put forward rather reasonable model of the gravity force. In this paper more detailed and corrected version of the model is presented.

Key words: informational model, relativity theory, gravity, experimental testing

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1 Introduction

In [1 - 3] it was rigorously shown that Matter in our Universe – and Universe as a whole - are some informational systems (structures), which exist as uninterruptedly transforming [practically] infinitesimal sub-sets of absolutely infinite and fundamental Set "Information". This informational conception enables to propose the physical model (more see [4],[5]), which, when basing practically only on Uncertainty principle, adequately depicts the motion and interactions of particles in spacetime. In the model [subatomic] particles are some closed-loop algorithms that run on a "hardware", which consists, in turn, of a closed chain of elementary logical gates – "fundamental logical elements" (FLE), which are some (distinct, though) analogues of C. F. von Weizsäcker's 1950-54 years "Urs" [6]. The FLE's sizes in the spacetime in both - in the space and in the ("coordinate") time - directions are equal to Planck length, l_P, $l_P = (\frac{\hbar G}{c^3})^{1/2}$ ($\hbar$ is reduced Planck constant - the elementary physical

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action, G - gravitational constant, c- speed of light in the vacuum); the time interval of the FLE's "flip" is equal to Planck time, $\tau_P, \tau_P = \frac{l_P}{c}$.

1.1 Particles

Since particles' algorithms never stop (the FLEs are uninterruptedly flipping), the particle moves in 4D spacetime with constant speed that is equal to the standard speed of light. If the particle is at rest in the space, it moves with the speed of light in temporal direction only – "in the "time flow" direction". As an analogue of the "time flow" it seems be rather reasonable to introduce the "informational currents" (IC); and, besides, the fixed information variables:

- the time IC (t-IC):

$$j_t = \frac{1}{\hbar}\gamma m_0 c^2, \qquad (1)$$

- the space IC (s-IC):

$$j_x = \frac{1}{\hbar}\gamma m_0 c^2 \beta^2, \qquad (2)$$

- the fixed information:

$$\Delta I_M = \frac{\Delta M}{\hbar}. \qquad (3)$$

(v is the speed of a particle, $\beta = v/c, \gamma = 1/(1-\beta^2)^{1/2}$ is the Lorentz – factor of the particle motion, ΔM is the angular momentum, m_0 is the particle's rest mass. The dimensionality of the time and the space currents is [bit/s], the dimensionality of fixed information is [bit]). Besides note, that fixed information relates, quite naturally, also to the physical action, S.

The "material" length of a particle's algorithm [at rest] is equal to the particle's Compton length, $\lambda_C, \lambda_C = \frac{\hbar}{m_0 c}$.

So through a particle's circular logical chain at rest an active "flipping point" runs uninterruptedly, having momentum, $p_P, p_P = \hbar/\lambda_C = m_0 c$, and angular momentum (for example – the photon's spin), $\hbar$.

At that particles are some disturbances in Aether, which is the dense 4D lattice of 4D FLE in the spacetime. If in Aether a flipping point runs through a straight line (in a space or in the time direction), then corresponding "particle" has infinite Compton length, so the "particle" has zero rest mass and zero momentum – as for the case when FLE doesn't flip at all. But some impact with non-zero momentum p in this (or in any direction for non-flipping FLE) direction results in the creation of a particle – at the impact in the time direction it is "usual"

material particle ("T-particle") having the mass $m_0 = p'/c; p' \le p$ and the energy $E = pc = \gamma m_0 c^2$; the impact in a space direction results in the occurrence of "S-particle", e.g. – of a photon having also the energy $E = pc$.

Any [of known now] particle's Compton length is much larger the Planck length, what allows "to write" on this length a code that defines the particle's parameters, but all (any particle's) codes contain "universally significant" FLEs - "us-FLEs", that flip in the end of the algorithm, i.e. in the end of particle's Compton length. And just these FLEs determine the location of the particle in spacetime, besides it is rather probable (see below) that these FLEs are responsible also for the gravity interactions between particles (and, of course, – between bodies).

1.2 Forces in the informational model

In the informational model seems as quite plausible the conjecture that at an interaction of a force's mediator with a particle some t-IC step in this particle becomes "be spent" by interaction, resulting in the particle's t-IC's decrease (if resulting decrement of energy, $\Delta U < 0$) and in corresponding mass defect of impacted particle/ body; or "be added" resulting in t-IC increase if $\Delta U > 0$. Besides at the interaction the mediator transmits to the impacted particle a momentum, $\vec{p}_0$.

2 Gravity model

2.1 Basic assumptions

It is possible to put forward, [1] rather reasonable conjecture - since the gravity force is universal (regardless to the kind of particles) - that the gravitational potential energy of a system of some bodies is proportional to the accidental coincidence rate of some interactions of the t-ICs of the particles of these bodies. Such coincidences always exist since the FLE's flip-time is not equal zero. Secondly suppose that in gravity interaction only us-FLEs, i. e. the FLEs that are used for localization of particle in space, take part.

Basing only on approach of section 1 and the conjectures above, the equation for potential gravitational energy can be obtained as follows.

As that was assumed above, the FLE's sizes are equal to Planck's length, l_P. Besides assume that:

(i) - at every t-IC step of a particle in space a "rim" (further "graviton") of spatial FLEs flips starts to expand *in the space* with radial speed that is equal to the speed of light, *c*, so the rim's area is equal $2\pi r l_P$ ($2\pi c t l_P$) see Fig.1

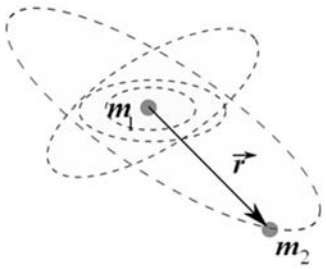

Fig. 1. A sketch of a spreading of the gravitons in the space. The direction of the spreadings is random since in reality any particle is impacted by some forces and isn't oriented in the space constantly.

(ii) - the times of the us-FLE's flip, and of the interaction of the graviton's FLE and particle's us-FLE are the same and are equal to Planck time; and

(iii) – at interaction of graviton and particle's us-FLE the particle is gravitationally impacted.

2.2 The model. T-particles

According to Newton, if two bodies have *gravitational* masses m_1 and m_2 and are in space on a distance r, then the gravitational energy, E_{gN}, is equal

$$E_{gN} = -\frac{Gm_1m_2}{r}. \qquad (4)$$

It is evident, that interactions of gravitons and particles' us-FLEs are accidental events – coincidences of independent processes of "radiation" and spreading of gravitons of "radiating" particle and us-FLE flipping of other one. In previous papers ([1]-[4]) the coincidence rate in a particle was estimated in suggestion that both – the number of "gravitons" in a point, where a particle's us-FLE flips, and the number of these us-FLE flips, are random; at that both numbers are distributed under Poisson law with the averages n_1 and n_2. Then, if both [average] numbers inside Plank time interval are small, then it is well known that the coincidence rate is equal

$$N_c \approx 2n_1n_2\tau \qquad (5)$$

In reality the particle's us-FLEs flips very regularly; nonetheless the equation (5) remains be true, if one suggests that the interaction of graviton and particle's usFLE happens in any time moment when the both Plank intervals overlap (Fig. 2).

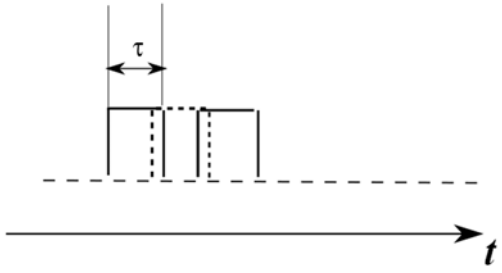

Fig. 2. Overlapping of gravitons and us-FLE

Thus the coincidence rate in a particle for the time when the particle's universal FLE flips again is

$$N_c = \psi_r n_p 2\tau \qquad (6)$$

where ψ_r is the flow [s^{-1}] of gravitons through the particle's usFLE; n_p is the us-FLE's flip rate (the informational current in the particle).

From the suggestions above obtain that the average gravitons flow, which is produced by a body having a mass m_1 is equal

$$\psi_r = \frac{m_1 c^2}{\hbar}\frac{2\pi l_P r}{4\pi r^2} = \frac{m_1 c^2 l_P}{2\hbar r} \qquad (7)$$

and the coincidence rate is

$$N_{c12} = \frac{m_1 c^2}{\hbar}\frac{l_P}{2r}\frac{m_p c^2}{\hbar}2\tau = \frac{m_1 c_2}{\hbar}\frac{l_P}{2r}\frac{m_p c^2}{\hbar}2\frac{l_P}{c} = \frac{m_1 m_p c^3 {l_P}^2}{\hbar^2} \qquad (8)$$

Since the Plank length is equal $l_P = (\frac{\hbar G}{c^3})^{1/2}$, from Eq.8 obtain, that the coincidence rate in the particle is equal

$$N_{c12} = \frac{G m_1 m_p}{\hbar r} \qquad (9)$$

It is evident, that if a body having mass m_2 contains any number of particles, then the coincidence rate in the body is equal

$$N_{c12} = \frac{G m_1 m_2}{\hbar r} \qquad (9a)$$

Note that the masses m_1 and m_2 in the equations (9), (9a) above are the *inertial* masses

Since the interaction of the bodies is symmetrical, the coincidence rate in the first body is equal to the rate in the second one: $N_{c12} = N_{c21} = \frac{Gm_1m_2}{\hbar r}$, so total gravitational energy, defined here in the informational model, E_{gIt}, seems as

$$E_{gIt} = -\hbar(N_{c12} + N_{c21}) = -2\frac{Gm_1m_2}{r}.$$

What, of course, contradicts the Newton gravity law, where, though, both masses are *gravitational* masses. But in reality, if there is no forces besides the gravity that affect on the bodies, the bodies' us-FLE flips must be spend on the bodies spatial motion also (with increasing of the bodies' kinetic energy), and so only half of total the coincidence rate transforms into the binding (potential) energy of the bodies. Thus obtain that the correct equation for this energy is

$$E_{gI} = -\frac{Gm_1m_2}{r} \qquad (10)$$

and $E_{gI} = E_{gN}$, when this energy (and corresponding mass defect) is equally divided between the bodies:

$$E_{gI1} = E_{gI2} = -\frac{Gm_1m_2}{2r}\ . \qquad (11)$$

Note that from above follows that *the gravitational and the inertial masses of a body are identical*, since both "are created" by the same informational current of the body.

For the gravitational forces by what the bodies attract each other obtain

$$F_{gI12} = \frac{dP}{dt} = -\frac{\hbar}{r}N_{c12} = -\frac{Gm_1m_2\vec{r}}{r^3} = F_{gI21}\ , \qquad (12)$$

where P is momentum of a body, when suggesting that the transfer of the elementary momentum, $P_e = -\frac{\hbar}{r}$, happens at *every* interaction of the us-FLE and graviton.

Some examples

Substituting real values in the equation for the gravitons flow we can obtain the estimation of average number of gravitons, which cross the FLE's area, l_P^2 inside the interaction time:

$$\psi_r\tau = \frac{mc^2l_P}{\hbar r}\tau \equiv \alpha \approx 7.46\cdot 10^{-28}\frac{m[kg]}{r[m]},$$

and the probability of these gravitons number, k

$$P(k) = \frac{\alpha^k e^{-\alpha}}{k!}$$

The probability of two and more crossing is

$$P(k>1) = 1 - e^{-\alpha} - \alpha e^{-\alpha} \to [\alpha << 1] \approx \alpha^2$$

For "usual" bodies α is rather small value. On the Sun's ($M \approx 1.99 \cdot 10^{30} kg; R \approx 7 \cdot 10^8 m$) surface $\alpha \approx 4 \cdot 10^{-6}$ and the rate of "overlaps" $\sim 10^{-11}$; on Earth - $\sim 10^{-20}$. But for exotic objects the overlaps influence can be appreciable:

- for a neutron star (let - $M_{NS} = 2M_{San}; R = 1.2 \cdot 10^4 m$) $\alpha \approx 0.25$, the rate is ~7% (rough estimate since the α value here isn't small).

for (GR) black hole $r = \frac{2GM}{c^2}$ and $\alpha = 0.5$

What happens when the overlaps of gravitons appear? It seems that there are 3 possibilities: (1) – the us-FLE when flipping can react (i.e. flip) with all gravitons inside the interval (seems a little probability); (2) – the us-FLE reacts only with 1 graviton, the rest (>1) gravitons disappear; and (3) - the FLE reacts only with 1 graviton, but the rest gravitons remain and after "scattering" can interact with some other particle.

All these versions are some subject for further investigation provided that this gravity model will be confirmed experimentally.

From above follows that the informational currents of both bodies becomes be slowed on the half binding energy (divided by $\hbar$, of course). If the mass, M, of one of the bodies much greater then the other mass, m, the relative decrease of this body's informational current is

$$\delta j_{t2} = \frac{GMm}{2\hbar r} \frac{\hbar}{mc^2} = \frac{GM}{2rc^2} \qquad (13)$$

Correspondingly, if the body-2 is a clock, the clock becomes be "gravitationally time dilated" on $\frac{GM}{2rc^2}$ times, what is twice lesser then that is asserted in the general relativity theory.

If a pair of clocks are placed on different radii (Fig.3), r and $r + h; h << r$ in a gravity field (Fig. 3)

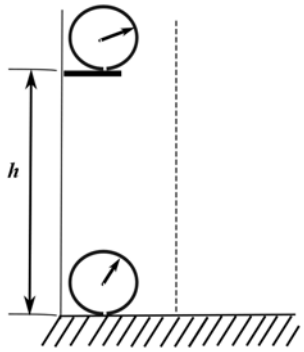

Fig. 3. Two clocks are in [let – Earth] gravity field. Dotted line – a photon beam.

then their tick the rates differ as

$$\delta\omega_1 - \delta\omega_2 = \frac{GM}{2c^2}\left(\frac{1}{r} - \frac{1}{r+h}\right) \approx \frac{GMh}{2r^2c^2}. \qquad (14)$$

For Earth surface $\delta\omega_1 - \delta\omega_2 \approx \frac{gh}{2c^2}$, where g is the gravitational acceleration. In the GR the difference is twice more - $\delta\omega_1 - \delta\omega_2 \approx \frac{gh}{c^2}$.

2.3 The model. Photons

One of main postulates in general relativity is that photons don't change their energy and frequency when moving in a gravity field (e.g. [7]) and the application to a photon the notion "mass" as $m_{ph} = E/c^2$ in this case is principally incorrect. If photon has mass then it must increase or decrease energy at motion between space points with different gravitational potential. For example at motion on distance h (Fig. 3) straight up/down relating to Earth surface the photon's frequency also must change on the same value $\frac{gh}{c^2}$. So, if photons have mass and change energy in gravity field, then, e.g., in R. Pound, G. Rebka and J. Snider experiments [8, 9] the frequency shift of gamma quanta must be equal to $2\frac{gh}{c^2}$, since the emitter's and photon detector's atoms frequencies differ also on the $\frac{gh}{c^2}$ - when the measured value was twice lesser – in accordance with the GR.

In the informational model photons are S-particles and move in the space only, at that they cannot – in contrast to the "massive" T- particles/ bodies – be stopped; the photon's energy is

$E = \hbar\omega$ and, as that is true for any – T- or S-particle – the energy and the momentum of a photon relate as $E = cP$. As well as T-particle also have the energy $E = \hbar\omega \equiv \hbar[j_t]$, so here aren't principal difference between T- and S- particles. So in the informational model we can apply the notion "mass" for photons.

If we apply the approach above to the photons and suggest that the photon has mass $m = E / c^2$, then obtain equations for the photon the rate of coincidences

$$N_c = \frac{GMPc}{\hbar rc^2} = \frac{GM\hbar\omega}{\hbar rc^2}, \qquad (15)$$

for photon's part of the potential energy of a system

$$\Delta E = \frac{GM\hbar\omega}{2rc^2}, \qquad (16)$$

and for the frequency shift ("red"/ "blue") if the photon moves straight up/ straight down on a distance h (let – system [Earth+photon])

$$\Delta\omega \approx \frac{GM\omega h}{2r^2c^2}, \text{ or } \delta\omega \approx \frac{gh}{2c^2} \qquad (17)$$

For the photon's momentum obtain

$$\Delta P \approx \pm N_c \frac{\hbar}{r}\frac{h}{c} = \pm\frac{\hbar GM\omega h}{r^2c^3} = \pm P\frac{gh}{c^2} \qquad (18)$$

where "+" relates to the strait down and "-" relates to straight up motions.

2.3.1 Photon beam declination in a gravity field

If a light beam moves by a mass *M* so that minimal distance is equal to ρ (Fig. 4),

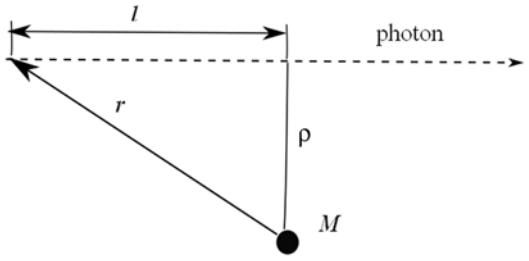

Fig. 4. A photon moves by the mass M on the distance ρ

then on the pass dl the photon's momentum changes on dP

$$dP = \pm\frac{\hbar GM\omega}{r^2c^3}dl = \pm P\frac{GM}{r^2c^2}dl, \qquad (19)$$

at that the vertical component of the momentum is

$$dP_v = \frac{GMP}{c^2}\frac{\rho}{(\rho^2 + l^2)^{3/2}}dl\,, \qquad (20)$$

thus the integrated value, if l changes from $-\infty$ to $+\infty$ is

$$\Delta P_v = \frac{2GMP}{\rho c^2}\,. \qquad (21)$$

If $\Delta P << P$ then the angle on what the beam will be declined is

$$\Delta\varphi \approx \Delta P / P = \frac{2GM}{\rho c^2}\,; \qquad (22)$$

what is twice lesser then the estimation in general relativity.

3 Conclusion

Above the model of the gravity is presented, which follows only from a couple of reasonable suggestions, which, in turn, are based on common corollaries of the informational conception; and which, in turn, is rigorously proven. So the obtained Eq. (10) by no means follows from both – from [experimental] Newton's gravity law and from Planck's approach at obtaining his "natural units". Thus Eq. (10) seems as rather possibly non - accidental and so there is non-zero probability that it (and the model as a whole) is true.

From the model a number of interesting implications follow. First of all – the identity of the gravitational and the inertial masses, at least for the static case. If interacting bodies move, then the identity in certain sense disappears, for example the inertia of moving body becomes be dependent on – on what direction relating to the motion direction the body is impacted.

However for the always moving particles, i.e., - photons, the model works well in the case, when a gravity field gradient and a photon motion have the same directions, for example – if a photon moves vertically to Earth surface. At that (not only in this case, of course, though) on the photon's energy/ frequence two factors act – the changing of the potential energy (for the case in the Fig. 3 $\delta\omega \approx \frac{gh}{2c^2}$) and the changing of the momentum, for the case in the Fig. 3 $\Delta P \approx \pm P\frac{gh}{c^2}$, what changes, of course, on the photon's frequency also: $\delta\omega_P \approx \pm\frac{gh}{c^2}$. But the factors act oppositely – at the straight up motion the potential energy decreases (the photon becomes bluer), but ΔP is negative and so the photon reddens. That results in the reddening of the photon and final frequency shift is $\delta\omega \approx \frac{gh}{2c^2}$. On another hand,

the clocks (atoms) frequency shift cannot be equal to $\frac{GM}{rc^2}$, as that is posited in the GR, since then on equal value the potential energy of another body must be changed and total potential energy of the system of bodies turns out to be twice more then the real one, what is impossible. So relative clocks frequency shift (for the Fig. 3 case) is as it is in this model - $\delta\omega_1 - \delta\omega_2 \approx \frac{gh}{2c^2}$.

In Pound et. al. experiments above both these factors (changing of photon and detector's atoms frequencies) acted, what resulted in the famous outcome $\delta\omega_1 - \delta\omega_2 \approx \frac{gh}{c^2}$.

The general model for arbitrarily moving bodies, as well as – to comply with the experimental data about the photon beams declination, if these data are reliable enough, should be developed on further elaboration of the model.

The model can be effectively tested – besides that it is obviously in accordance with outcomes of any experiments that tested the Newton law, it has the individual trait. From the model, where the gravity force is principally stochastic (in contrast to, e.g., the GR) follows the possibility to observe this randomness, when some very small masses interact. Possible – and executable yet now - experiments are presented in [10], [11]. At that the experiment with measurement of random frequency distortion in Earth gravity seems as utmost perspective and can be made now, since there exist necessary instruments and techniques: the stabilized photons sources [12], [13]; and precise interferometers. For example that could be the instruments intended for detection of the gravity waves [14]- [16], if an additional vertical (e.g., in a borehole) interferometer's arm will be appended. Since in this case it is enough to have all arms having lengths ~ 300-400 m, TAMA300 detector [16] seems as at most (since lower cost) promising.

Besides – such an installation can be possibly used for testing of other models of quantum gravity.

Note, however, that the estimations of frequency shifts at gravity impact on photons that are presented in [10] and [11] are incorrect and should be in two times decreased. For example, the minimal shift that in [10] is equal 3.7 Hz, after the correction here is equal to ~1.8 Hz, etc.

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