Gravity, Planck constant, structure of elementary particles

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PRELUDIUM

$$m_0c^2 = const$$

$$m_0c^2 = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}} = const\ ,\ v^2 << c^2$$

$$m_0c^2 \approx mc^2\left(1+\frac{1}{2}\frac{v^2}{c^2}+...\right)$$

$$m_0c^2 \approx mc^2 + \frac{mv^2}{2} = const\text{ , note }\ m_0 > m$$

Free fall in weak gravitational field

$$m_1c^2 + \frac{m_1{v_1}^2}{2} = m_2c^2 + \frac{m_2{v_2}^2}{2} = ... = const$$

Free fall in every gravitational field

$$\frac{m_1c^2}{\sqrt{1-\frac{{v_1}^2}{c^2}}} = \frac{m_2c^2}{\sqrt{1-\frac{{v_2}^2}{c^2}}} = ... = const$$

Note $m_0 > m_1 > m_2 > ...$

$... > v_2 > v_1 > 0$

INTRODUCTION

There is correct opinion, that clock which is elevated 100 *m* above the surface of the Earth will go faster then the same one on the suffice. If those clocks had torsion pendulum as its vital part, would that be rule for them too?

Sure it would. What about all other particles? Does every particle oscillate somehow, and does every particle have some “pendulum” as its vital part? Yes.

Apparently everything is made of something small that oscillate. Everything has its frequency, and we usually say if something oscillates at grater frequency, then its energy is bigger.

CLAIM [1]

Every mass consist off oscillators, energy of these oscillators is directly dependent of its frequency, frequency is dependent of duration of the time interval, and time interval depends of gravitational field.

Gravity is tendency to bee in lower energy state.

One body is drone to another because together they have lover mass (lover potential energy). Body of 1 *kg* elevated on 100 *m* above the Earth has bigger potential energy for

$$\Delta E \approx mgh \approx 981J$$

and bigger mass, for approximately

$$\Delta m \approx mgh/c^2, \Delta m \approx 1.09 \cdot 10^{-14}\ .$$

Mass is the measurement of potential energy of body, by Einstein's equation $E_0 = mc^2$. In gravitational field this potential energy is reduced.

CALCULATION

Basic equations:

Energy of quantum oscillators:

$$E_n = \left(n + \frac{1}{2}\right)\hbar\omega\ .$$

Basic energy of quantum oscillators:

$$E = \frac{\hbar\omega}{2}$$

and:

$$T = \frac{2\pi}{\omega}\ .$$

Basic energy of quantum oscillators is dependent of time interval

$$\boldsymbol{E} = \frac{\boldsymbol{\hbar\pi}}{\boldsymbol{T}}\ .$$

[1] I rather wouldn't make any claims, but if its needed there it is.

Well-known equation (SEE ADDITION [1]) for time interval out (T_0) and in (T) gravitational field, which is created by mass M at distance R:

$$\frac{1}{T} = \frac{1}{T_0}\sqrt{1-\frac{2\gamma M}{Rc^2}} \qquad \Big/ \hbar\pi$$ [2]

$$\frac{\hbar\pi}{T} = \frac{\hbar\pi}{T_0}\sqrt{1-\frac{2\gamma M}{Rc^2}}\,.$$

Therefore:

$$E = E_0\sqrt{1-\frac{2\gamma M}{Rc^2}}$$

E - potential energy (of mass m in gravitational field created by mass M at distance R,)[3]
E_0 - potential energy (of mass m outside gravitational field, $E_0 = m_0c^2$)[4]

$$mc^2 = m_0c^2\sqrt{1-\frac{2\gamma M}{Rc^2}}$$

or

$$m = m_0\sqrt{1-\frac{2\gamma M}{Rc^2}}$$

mass defect $\Delta m = m_0 - m$

$$\Delta m = m_0\left(1-\sqrt{1-\frac{2\gamma M}{Rc^2}}\right).$$

WEAK GRAVITATIONAL FIELDS

Approximation

$$\frac{2\gamma M}{Rc^2} << 1$$

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[2] $\hbar = \frac{h_0}{2\pi}$ - Reduced Planck constant, $h_0 = 6{,}626\cdot 10^{-34}\,Js$ -real Planck constant

[3] Strictly speaking, these equations hold for energy of one oscillator, but it can be applied for any mass which is consistent of more different kind and number of oscillators, because equations holds for any of them...

[4] Outside gravitation field $m = m_0$

$$T = \frac{T_0}{\sqrt{1-\frac{2\gamma M}{Rc^2}}}$$, series expansion[5]

$$T = T_0\left(1+\frac{1}{2}\frac{2\gamma M}{Rc^2}+\frac{3}{8}\left(\frac{2\gamma M}{Rc^2}\right)^2+...\right)$$

$$T \approx T_0\left(1+\frac{\gamma M}{Rc^2}\right)$$

$$\frac{\hbar\pi}{T} = \frac{\hbar\pi}{T_0}\frac{1}{1+\frac{\gamma M}{Rc^2}}$$, series expansion

$$\frac{\hbar\pi}{T} = \frac{\hbar\pi}{T_0}\left(1-\frac{\gamma M}{Rc^2}+\left(\frac{\gamma M}{Rc^2}\right)^2+...\right)$$

$$\frac{\hbar\pi}{T} \approx \frac{\hbar\pi}{T_0}\left(1-\frac{\gamma M}{Rc^2}\right)$$

$$E = E_0\left(1-\frac{\gamma M}{Rc^2}\right)$$

E - potential energy (of mass *m* in gravitational field created by mass *M* at distance *R,*)[6]
E_0 - potential energy (of mass *m* outside gravitational field, $E_0 = m_0c^2$)

Under condition:

$$\frac{2\gamma M}{Rc^2} << 1$$

TWO CASES OF WEAK FIELDS

1) Approximation for $\frac{2\gamma M}{Rc^2} << 1$ and $h<<R$

$$E = E_0\left(1-\frac{\gamma M}{Rc^2}\right)$$

$$E_E = E_0\left(1-\frac{\gamma M}{Rc^2}\right)$$

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[5] $\gamma = 6{,}673\cdot 10^{-11}\frac{m^3}{kgs^2}$ - gravitational constant

[6] Mass *m* is **not equal** on different heights, but for these calculations that difference is not relevant, although mass difference is key phenomenon…See page 1, when we lift 1 kg its almost the same as we lift $1+1{,}09\cdot 10^{-14}\,kg$.

$$E_h = E_0\left(1-\frac{\gamma M}{(R+h)c^2}\right)$$

E_E - potential energy of mass m in gravitational field created by mass M at distance R
E_h - potential energy of mass m in gravitational field created by mass M at distance $R+h$

$$E_h = E_0\left(1-\frac{\gamma M}{c^2}\frac{1}{R}\frac{1}{1+\frac{h}{R}}\right)$$, series expansion

$$E_h = E_0\left(1-\frac{\gamma M}{c^2}\frac{1}{R}\left(1-\frac{h}{R}+\left(\frac{h}{R}\right)^2-...\right)\right)$$

$$E_h \approx E_0\left(1-\frac{\gamma M}{c^2}\frac{1}{R}+\frac{\gamma M}{c^2}\frac{h}{R^2}\right)$$

difference between potential energies E_h and E_E

$$E_h - E_E = E_0\left(1-\frac{\gamma M}{c^2}\frac{1}{R}+\frac{\gamma M}{c^2}\frac{h}{R^2}\right) - E_0\left(1-\frac{\gamma M}{Rc^2}\right)$$

$$E_h - E_E = E_0\frac{\gamma M}{c^2}\frac{h}{R^2}$$

$$E_h - E_E = mc^2\frac{\gamma M}{c^2}\frac{h}{R^2}$$

$$E_h - E_E = m\frac{\gamma M}{R^2}h$$, if it's Earth, $\frac{\gamma M}{R^2} = g$

difference between potential energies at height h and surface

$$E_h - E_E = mgh.$$

2) Approximation for $\frac{2\gamma M}{Rc^2} << 1$ and H comparable R.

$$E_E = E_0\left(1-\frac{\gamma M}{Rc^2}\right)$$

$$E_H = E_0\left(1-\frac{\gamma M}{(R+H)c^2}\right)$$

$$E_H - E_E = E_0\left(1 - \frac{\gamma M}{(R+H)c^2}\right) - E_0\left(1 - \frac{\gamma M}{Rc^2}\right)$$

$$E_H - E_E = E_0\left(1 - \frac{\gamma M}{(R+H)c^2} - 1 + \frac{\gamma M}{Rc^2}\right)$$

$$E_H - E_E = mc^2\left(-\frac{\gamma M}{(R+H)c^2} + \frac{\gamma M}{Rc^2}\right).$$

Difference between potential energies

$$E_H - E_E = -\gamma\frac{mM}{(R+H)} - \left(-\gamma\frac{mM}{R}\right).$$ [7]

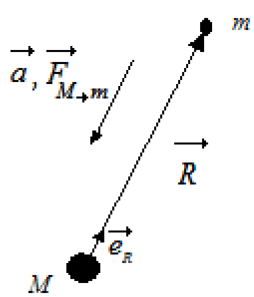
GRAVITATIONAL FORCE, GRAVITATIONAL ACCELERATION

1) Gravitation field of unlimited strength (created by mass *M*), under condition $m << M$ (apple-Earth, Mercury-Sun, neutron star-marble, electron-photon[8]).

The total potential energy E

$$E = E_0\sqrt{1 - \frac{2\gamma M}{Rc^2}}$$

$$mc^2 = m_0 c^2\sqrt{1 - \frac{2\gamma M}{Rc^2}}$$



$$\vec{e}_R = \frac{\vec{R}}{R}$$

$$\vec{a} = a(-\vec{e}_R)$$

$$\vec{F} = F(-\vec{e}_R)$$

force exerted on mass *m* at distance *R* by mass *M*

$$\vec{F}_{M\to m} = -gradE = -\frac{\partial}{\partial R}(E)\vec{e}_R$$

$$-\vec{e}_R F_{M\to m} = -\vec{e}_R\frac{\partial}{\partial R}(E)$$

$$F_{M\to m} = \frac{\partial}{\partial R}E$$

[7] important examples SEE ADDITION [2]

[8] I'm not saying that gravity holds photon in electron, I'm saying that is possible.

$$F_{M\to m} = \frac{\partial}{\partial R}\left(m_0 c^2 \sqrt{1-\frac{2\gamma M}{Rc^2}} \right)$$

$$F_{M\to m} = m_0 c^2 \frac{1}{2\sqrt{1-\frac{2\gamma M}{Rc^2}}}\left(-\frac{2\gamma M}{c^2}\right)\left(-\frac{1}{R^2}\right)$$

$$F_{M\to m} = \frac{m_0 \gamma M}{R^2}\frac{1}{\sqrt{1-\frac{2\gamma M}{Rc^2}}} \quad ; \qquad m_0 = m\frac{1}{\sqrt{1-\frac{2\gamma M}{Rc^2}}}$$

force exerted on mass *m* at distance *R* by mass *M*

$$F_{M\to m} = \gamma\frac{mM}{R^2}\frac{1}{1-\frac{2\gamma M}{Rc^2}}$$

$$\vec{F}_{M\to m} = -\gamma\frac{mM}{R^2}\frac{1}{1-\frac{2\gamma M}{Rc^2}}\vec{e}_R$$

$$\vec{F}_{M\to m} = m\vec{a}$$

$$ma = \gamma\frac{mM}{R^2}\frac{1}{1-\frac{2\gamma M}{Rc^2}}$$

acceleration a exerted on mass *m* at distance *R* by mass *M*

$$a = \gamma\frac{M}{R^2}\frac{1}{1-\frac{2\gamma M}{Rc^2}}$$

$$\vec{a} = -\gamma\frac{M}{R^2}\frac{1}{1-\frac{2\gamma M}{Rc^2}}\ \vec{e}_R\ .$$

Example:

Photon sphere radius

Centripetal acceleration needed to hold photon on circular orbit is:

$$a_c = \frac{c^2}{R_{ph}}.$$

If that centripetal acceleration is provided by gravitational pull of mass *M,* then:

$$a_c = \gamma \frac{M}{R_{ph}{}^2} \frac{1}{1 - \frac{2\gamma M}{R_{ph} c^2}}$$

$$\frac{c^2}{R_{ph}} = \gamma \frac{M}{R_{ph}{}^2} \frac{1}{1 - \frac{2\gamma M}{R_{ph} c^2}}$$

$$c^2 = \gamma \frac{M}{R_{ph}} \frac{1}{1 - \frac{2\gamma M}{R_{ph} c^2}}$$

$$R_{ph}\left(1 - \frac{2\gamma M}{R_{ph} c^2}\right) = \frac{\gamma M}{c^2}$$

$$R_{ph} - \frac{2\gamma M}{c^2} = \frac{\gamma M}{c^2} \quad .$$

Photon sphere radius R_{ph}

$$R_{ph} = 3\frac{\gamma M}{c^2}.$$

In all calculation so far in first equations where is appearing mass *M,* should be standing M_0 instead, and then under condition $\frac{\partial M_0}{\partial R} = 0$ and for $m << M \Rightarrow \ M_0 \approx M ...$ and further as is. I wasn't writing that because it would drown attention to wrong things at that time. Now follows correct equations and hopefully correct interpretations.

GENERAL EQUATIONS

Basic low, which determinate gravitational interaction between mass m and M. [9]
For **all** strengths and **all** sizes of (R).

$$m_0 c^2 = \frac{mc^2}{\sqrt{1 - \frac{2\gamma M_0}{Rc^2}}} = const$$

$$M_0 c^2 = \frac{Mc^2}{\sqrt{1 - \frac{2\gamma m_0}{Rc^2}}} = \text{const}$$

Note that M_0 and m_0 are constant expressed in *kg*, on the other hand, although they are constants they are combination off variables and are measurement of total energy which creating gravitational attraction. Even if mass of object is changing during attraction (under condition that is changing its relative position) **gravitational attraction is as if mass is constant.**

Only rational explanation which I have is that **energy,** like mass, creating gravitational field in known measurement $m = \frac{E}{c^2}$.

[9] Isolated from all other influence

Let's work again on same example from page.6.
Mathematically correct

1) Gravitation field of unlimited strength (created by mass M), under condition $m << M$ (apple-Earth, Mercury-Sun, neutron star-marble, electron-photon).

Basic equation

$$m_0c^2 = \frac{mc^2}{\sqrt{1-\frac{2\gamma M_0}{Rc^2}}} = const$$

$$M_0c^2 = \frac{Mc^2}{\sqrt{1-\frac{2\gamma m_0}{Rc^2}}} = \text{const}$$

$$\frac{\partial}{\partial R}\left(m_0c^2\right) = \frac{\partial}{\partial R}\left(\frac{mc^2}{\sqrt{1-\frac{2\gamma M_0}{Rc^2}}}\right)$$

$$0 = \frac{\sqrt{1-\frac{2\gamma M_0}{Rc^2}}\frac{\partial}{\partial R}\left(mc^2\right) - mc^2\frac{1}{2\sqrt{1-\frac{2\gamma M_0}{Rc^2}}}\left(\frac{-2\gamma M_0}{c^2}\right)\left(-\frac{1}{R^2}\right)}{\left(\sqrt{1-\frac{2\gamma M_0}{Rc^2}}\right)^2}$$

$$\frac{\partial}{\partial R}\left(mc^2\right) = \gamma\frac{mM_0}{R^2}\frac{1}{1-\frac{2\gamma M_0}{Rc^2}}.$$

Under condition $m << M$, and R is identical, implies $\frac{2\gamma m_0}{Rc^2} << \frac{2\gamma M_0}{Rc^2}$, and from basic equations it follows that $M_0c^2 \approx Mc^2$ that is $M_0 \approx M$

$$\frac{\partial}{\partial R}\left(mc^2\right) = \gamma\frac{mM}{R^2}\frac{1}{1-\frac{2\gamma M}{Rc^2}}$$

$$\vec{F}_{M\to m} = -\frac{\partial}{\partial R}\left(mc^2\right)\vec{e}_R .$$

Force exerted on mass *m* at distance *R* by mass *M*

$$\vec{F}_{M\to m} = -\gamma\frac{mM}{R^2}\frac{1}{1-\frac{2\gamma M}{Rc^2}}\vec{e}_R$$

2) Newton's **"Low of universal gravity"** as special case off basic low.[10]

Interaction between masses *m* and *M,* under conditions $\frac{2\gamma M_0}{Rc^2}$ <<1, and $\frac{2\gamma m_0}{Rc^2}$ <<1

$$m_0c^2 = \frac{mc^2}{\sqrt{1-\frac{2\gamma}{Rc^2}M\frac{1}{\sqrt{1-\frac{2\gamma m_0}{Rc^2}}}}}$$

$$m_0c^2 \approx \frac{mc^2}{\sqrt{1-\frac{2\gamma}{Rc^2}M\left(1+\frac{1}{2}\frac{2\gamma m_0}{Rc^2}+..\right)}}$$

$$m_0c^2 \approx \frac{mc^2}{\sqrt{1-\frac{2\gamma}{Rc^2}M-\frac{2\gamma}{Rc^2}M\frac{\gamma m_0}{Rc^2}}}$$

$$m_0c^2 \approx \frac{mc^2}{\sqrt{1-\frac{2\gamma}{Rc^2}M}}$$

$$m_0c^2 \approx mc^2(1+\frac{1}{2}\frac{2\gamma}{Rc^2}M+...)$$

$$m_0c^2 \approx mc^2+\gamma\frac{mM}{R^2}$$

$$\frac{\partial}{\partial R}\left(m_0c^2\right) \approx \frac{\partial}{\partial R}\left(mc^2+\gamma\frac{mM}{R^2}\right)$$

$$0 \approx \frac{\partial}{\partial R}\left(mc^2\right)+\frac{\gamma}{R}\frac{\partial}{\partial R}\left(mM\right)-\gamma\frac{mM}{R^2}$$

[10] Even if we see that from last equation, under $\frac{2\gamma M}{Rc^2}$ <<1

$$0 \approx 1\frac{\partial}{\partial R}\left(mc^2\right)+\frac{1}{2}\left(\frac{2\gamma M}{c^2 R}\frac{\partial}{\partial R}\left(mc^2\right)+\frac{2\gamma m}{c^2 R}\frac{\partial}{\partial R}\left(Mc^2\right)\right)-\gamma\frac{mM}{R^2}$$

$$\frac{1}{2}\left(\frac{2\gamma M}{c^2 R}\frac{\partial}{\partial R}\left(mc^2\right)+\frac{2\gamma m}{c^2 R}\frac{\partial}{\partial R}\left(Mc^2\right)\right) \approx verylittle \cdot verylittle << 1 * verylittle$$

$$0 \approx \frac{\partial}{\partial R}\left(mc^2\right)-\gamma\frac{mM}{R^2}$$

$$\frac{\partial}{\partial R}\left(mc^2\right) \approx \gamma\frac{mM}{R^2}$$

$$\vec{F}_{M\to m} = -\frac{\partial}{\partial R}\left(mc^2\right)\vec{e}_R$$

$$\vec{F} = -\gamma\frac{mM}{R^2}\vec{e}_R \, .$$

3) Something very similar

Interaction between two identical mass *m* under condition $\frac{2\gamma m_0}{Rc^2} << 1$

$$m_0 c^2 = \frac{mc^2}{\sqrt{1-\frac{2\gamma m_0}{Rc^2}}}$$

$$m_0 c^2 \approx mc^2(1+\frac{1}{2}\frac{2\gamma m_0}{Rc^2}+...)$$

$$m_0 c^2 \approx \frac{mc^2}{1-\frac{\gamma m}{Rc^2}}$$

$$\frac{\partial}{\partial R}\left(m_0 c^2\right) \approx \frac{\partial}{\partial R}\left(\frac{mc^2}{1-\frac{\gamma m}{Rc^2}}\right)$$

...

$$0 \approx \left(1-\frac{\gamma m}{Rc^2}\right)\frac{\partial}{\partial R}\left(mc^2\right)+\frac{\gamma m}{Rc^2}\left(\frac{\partial}{\partial R}\left(mc^2\right)-\frac{mc^2}{R}\right)$$

$$\frac{\partial}{\partial R}\left(mc^2\right) \approx \gamma\frac{m^2}{R^2}$$

…

4) We could do similar calculation for two identical mass, but without any limitation.

$$m_0c^2 = \frac{mc^2}{\sqrt{1-\frac{2\gamma m_0}{Rc^2}}}$$

$$m_0c^2 = F(m,R)$$

and from conditions

$$\frac{\partial}{\partial R}\left[f(mc^2,R)\right] = \frac{\partial}{\partial R}\left(m_0c^2\right) = 0$$

find

$$\frac{\partial}{\partial R}\left(mc^2\right) = f\left(m,R\right),$$

and from there force, acceleration...
Similar calculation holds for any two given mass at any distance. Calculation is long and tedious, and not belongs here.

Now follows one important example.

Non-isolated system

5) Distance assessment,
between two same masses, under very big mass defect and under complete dissipation of converted energy.

Until now everything was about two isolated body and their mutual interaction. Now are about two non-isolated bodies, where mass defect is real loss of energy. That energy is not vanishing, it goes for elevating energy of some other system.[11]

Correct equations for interaction of two isolated bodies

$$mc^2 = m_0c^2\sqrt{1-\frac{2\gamma M_0}{Rc^2}}$$

$$Mc^2 = M_0c^2\sqrt{1-\frac{2\gamma m_0}{Rc^2}}\ .$$

If there is complete loss of mass defect, loss of converted energy, then these equation is somewhat different.
For non-isolated system under complete loss of converted energy, holds:

$$mc^2 = m_0c^2\sqrt{1-\frac{2\gamma M}{Rc^2}}$$

$$Mc^2 = M_0c^2\sqrt{1-\frac{2\gamma m}{Rc^2}}\ .$$

[11] This is destruction, creation is other way around.

Gravitational interaction is smaller and smaller, masses *m* and *M* are getting lost. Energy is conduced away from system in known ratio.
For two identical masses holds:

$$mc^2 = m_0 c^2 \sqrt{1 - \frac{2\gamma m}{Rc^2}}$$

$$\frac{m^2}{m_0^2} = 1 - \frac{2\gamma m}{Rc^2}$$

$R = \frac{2\gamma m}{c^2} \frac{1}{1 - \frac{m^2}{m_0^2}}$, for great mass defect $m << m_0$

$$R \approx \frac{2\gamma m}{c^2}\left(1 + \frac{m^2}{m_0^2} + ...\right), \ \frac{m^2}{m_0^2} << 1.$$

Under great mass defect and with complete loss of converted energy, radius of imaginary sphere *R* in which mass *m* is. [12]

$$R \approx \frac{2\gamma m}{c^2},$$

R is close, but **always** bigger, **newer** equal to $\frac{2\gamma m}{c^2}$ …

LAW OF CONSERVATION OF ENERGY, DOPPLER EFFECT, PLANCK “CONSTANT“

We said that **total energy** of photon is given by equation $E = h\nu$, *h* – Planck “constant”, ν -frequency. As photon free fall[13] in gravitation field its frequency is bigger and bigger, but **its total energy is conserved.**

Law which governs change of the Planck “constant” could be find by applying low of energy conservation and Doppler effect in gravitation field.

$$E = E_0, \ h\nu = h_0\nu_0, \ \frac{h}{h_0} = \frac{\nu_0}{\nu}$$

[12] It’s impossible to put more mass inside this radius. If its field, electrical or other, it’s distributed inside but has a limit on density…
[13] Law that applies to marble applies to photon.

$$\nu = \sqrt{\frac{1+\frac{v}{c}}{1-\frac{v}{c}}}\nu_0 .$$

Low which governs change of the Planck “constant”.

$$h = \sqrt{\frac{1-\sqrt{\frac{2\gamma m}{Rc^2}}}{1+\sqrt{\frac{2\gamma m}{Rc^2}}}}h_0 .$$

Planck “constant” *h* in gravitational field created by mass *m* at a distance *R* and real Planck constant $h_0 \approx 6{,}626 \cdot 10^{-34}\,Js$.

How these change of the Planck ”constant” fit in this story so far?

Examples:

1) On the surface of the Earth electron and positron have certain masses (m_e), when they annihilate each other, two photons of frequency ν is released. Then we lift these electron and positron on height of 100 *m*, and during that we increase their masses for $1.09 \cdot 10^{-14} m_e$. Effectively we increased their energies, and if they annihilate each other on these height we will get two photon of **greater energy**[14], but frequency of that two photons is, ν **identical** like on surface.

2) 1 *kg* of water on height of 100 *m* has identical potential energy like 1 *kg* on surface of the Earth. But there is difference. On the Earth surface 1 *kg* off water have more H_2O molecules, approximately $\frac{1{,}09 \cdot 10^{-14}}{3 \cdot 10^{-26}} \approx 3{,}63 \cdot 10^{11}$, then 1 *kg* of water on height off 100 *m*.

(Calculated if in 1 *kg* have approximately $\frac{1}{3 \cdot 10^{-26}} \approx 3{,}33 \cdot 10^{25}$ water molecules)

[14] Energy increased by work exerted to lift electron and positron

Elementary particles, structure hypothesis

Neutron decay

$n \rightarrow p + e^{-}$

$(d + d + u) \rightarrow (d + u + u) + e^{-}$

My hypothesis for same phenomenon is

$n \rightarrow p + e^{-}$

$(d + d + \lfloor 2\tilde{d} \rfloor) \rightarrow (d + \lfloor 2\tilde{d} \rfloor + \lfloor 2\tilde{d} \rfloor) + [3d]$

or *d* quark decay to *u* quark and electron e^{-}

$d \rightarrow u + e^{-}$

My hypothesis for same phenomenon is

$d \rightarrow \lfloor 2\tilde{d} \rfloor + [3d]$

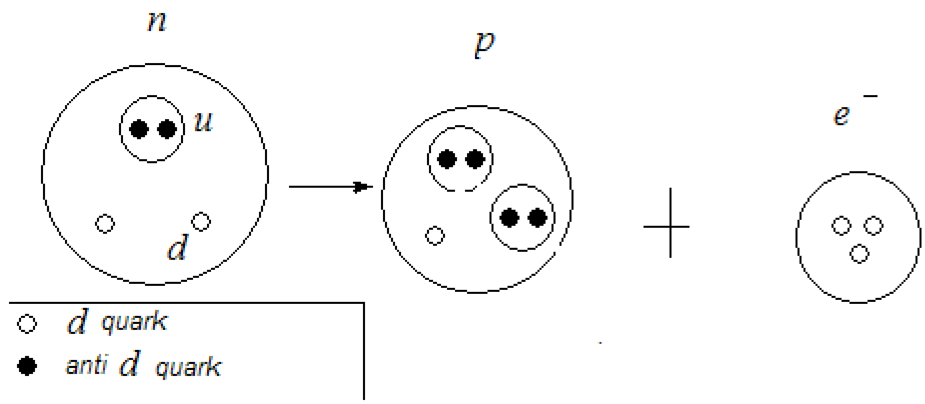
n	neutron
p	proton
$e^{-} = [3d]$	electron
d	down quark
$u = \lfloor 2\tilde{d} \rfloor$	up quark
...	

Some consequences [15]

1) Quark algebraic sum is same before and after reactions.
2) Up quark consists of two anti-down $(\tilde{d})$ quarks.
3) Electron consists of three down (d) quarks.
4) Then we could say that down (d) quark is only true particle and anti-down $(\tilde{d})$ quark is only true antiparticle, or vice versa. All other particle is combinations of these two. [16]
5) One of basic characteristic of down (d) quark is negative electric charge $-\frac{1}{3}e$, one of basic characteristic of anti-down $(\tilde{d})$ quark is positive electric charge $\frac{1}{3}e$. [17]
6) Electrostatic force is measurement of interaction between particle and anti-particle (particle).
7) If mass is only difference between two particles, then we don't have two different particles. We have same particles with different mass (different potential energy)…

[15] Although I'm not sure what is and do I need neutrino.
[16] Except photon.
[17] $e \approx 1{,}6 \cdot 10^{-19} c$

NOT IN SCALE



Masses of proton, neutron, electron

$m_p \approx 1{,}67 \cdot 10^{-27}\,kg$
$m_n \approx 1{,}67 \cdot 10^{-27}\,kg$
$m_e \approx 9{,}11 \cdot 10^{-31}\,kg$.

Masses of up quark and down quark in neutron and proton

$m_u + 2 \cdot m_d \approx 1{,}67 \cdot 10^{-27}\,kg$
$2 \cdot m_u + m_d \approx 1{,}67 \cdot 10^{-27}\,kg$
$m_u \approx m_d \approx \frac{1{,}67 \cdot 10^{-27}\,kg}{3} \approx 5{,}567 \cdot 10^{-28}\,kg$.

Mass of one *d* quark in electron

$m_{de} \approx \frac{1}{3} \cdot m_e \approx \frac{1}{3} \cdot 9{,}11 \cdot 10^{-31}\,kg \approx 3{,}037 \cdot 10^{-31}\,kg$.

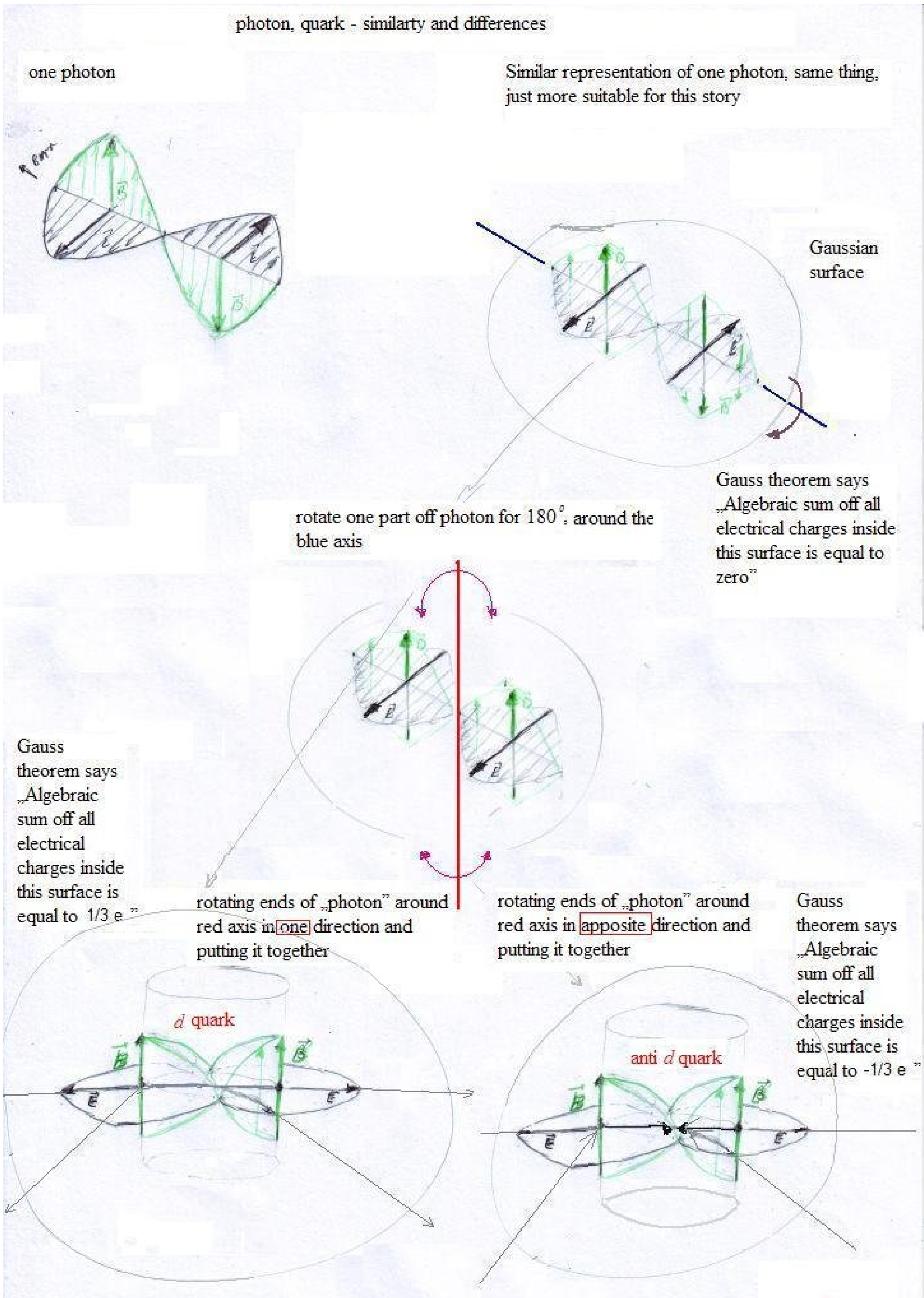
Mass of one anti down quark $\tilde{d}$ in up quark which is in neutron (proton)

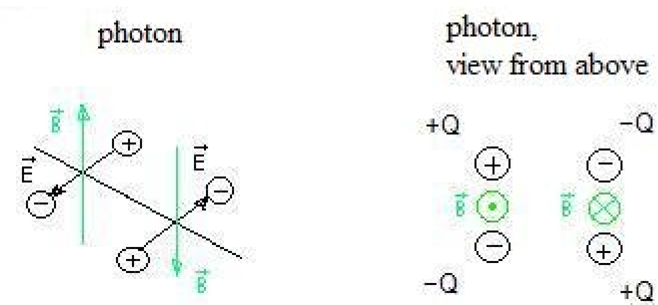
$m_{du} \approx \frac{1}{3}\frac{1}{2} \cdot m_p \approx \frac{1}{3}\frac{1}{2} \cdot m_n \approx \frac{1}{6} \cdot 1{,}67 \cdot 10^{-27}\,kg \approx 2{,}783 \cdot 10^{-28}\,kg$.

Mass of one “free“down *d* quark in proton (neutron)

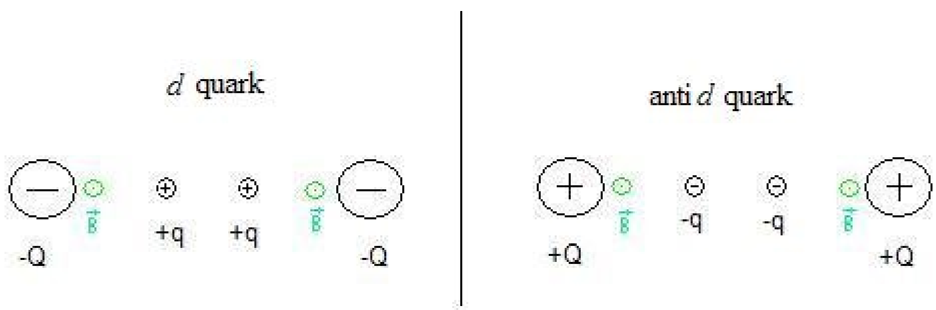
$m_{dp} \approx \frac{1}{3} \cdot m_p \approx \frac{1}{3} \cdot m_n \approx \frac{1}{3} \cdot 1{,}67 \cdot 10^{-27}\,kg \approx 5{,}567 \cdot 10^{-28}\,kg$.

Quark shape and structure hypothesis





quark, view from above

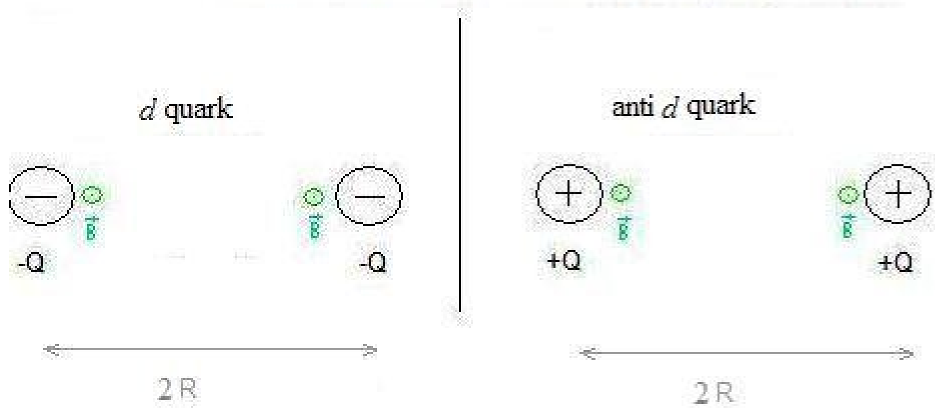


$$|+Q| = |-Q|$$
$$|+q| = |-q|$$
$$|\pm Q| > |\pm q|$$

$$2\,|\pm Q| - 2\,|\pm q| = \frac{1}{3}\,e$$

$$e = 1{,}6 \cdot 10^{-19}\ \text{c}$$

For rough assessment which fallows, is worked under approximation $|\pm Q| >> |\pm q|$, and will calculate as if quark looks like as in picture below



First sketch **is not** how quark is created, its just visualization of similarities to photon.

Before calculation for quark radius, I have to emphasize that even though I neglect internal electric charge it exist and it have very important role in interaction (it is, together with magnetic properties, responsible for nuclear and sub nuclear forces[18]…). Concretely, although we calculate *d* quark as if it has only negative electric charge (with that electron to), ***d* quark and electron have, inside of them, positive electric charge.**

MASS[19]

In the beginning of this story mass is considered to be measurement of basic energy of the quantum oscillator.[20]

$$m_0 = \frac{E_0}{c^2} = \frac{\hbar\omega}{2c^2}.$$

Now I say that basic mass of the quark (mass outside gravitational field) is measurement of electrical and magnetic potential energy within quark, (I don't think that is problem...).

$$m_0 = \frac{W_e + W_m}{c^2}, W_e = W_m.$$

Reminding and continuing.

Mass *m* in gravitational field of mass *M*

$$m_0 c^2 = \frac{mc^2}{\sqrt{1 - \frac{2\gamma M}{Rc^2}}}.$$

Because for $m << M \Rightarrow M_0 \approx M$.

Electrical potential energy of two same electrical charge *q* at distance *r*

$$W_{e_0} = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r} = m_0 c^2.$$

That same energy in gravitational field created by mass *M* at distance $R, r << R$.

$$W_{e_0} = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r} = m_0 c^2 = \frac{mc^2}{\sqrt{1 - \frac{2\gamma M}{Rc^2}}} \text{ or,}^{21}$$

[18] Bonding force within up quark and within electron.
[19] I rather wouldn't make any claims...
[20] That does not need to be quantum oscillator, equations holds for "any" kind of oscillations

$$W_e = mc^2 = W_{e_0}\sqrt{1-\frac{2\gamma M}{Rc^2}}$$

W_e - electrical potential energy in gravitational field created by mass M at distance R

W_{e_0} - electrical potential energy outside gravitational field.

Consequences:
There always have to be $W_e < W_{e_0}$

and because $W_{e_0} = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r}$.

For constant r under decrease of R, W_e declines. That means q is changing in gravitational field. Therefore follows $q' \neq q, q' < q$

q' electric charge in gravitational field
q electric charge outside gravitational field
ε_0 is true constant, it doesn't change in gravitational field.[22]

In similar way, in which mass defect occurs, there is electrical charge defect.

SOME COMMENT

Generally:
If we observe equation $\sqrt{1-\frac{2\gamma M}{Rc^2}}$, under condition that these equation hold for all distances R, and its seams it does, we see that $\frac{2\gamma M}{Rc^2} < 1$ **always** holds. More accurate and complete expression would be $\frac{2\gamma Mc^2}{Rc^4} = \frac{2\gamma E_{tot}}{Rc^4} < 1$
E_{tot} in this expression means **any** energy.

---

[21] $\varepsilon_0 \approx 8{,}85 \cdot 10^{-12}\,\frac{F}{m}$ - electric constant

[22] There is no change of ε_0 in gravitational field, because it would imply that speed of light is reduced in gravitational field. Although is tempting that would be very wrong concept.

It’s impossible to put energy E_{tot} in space less then $const \cdot R$ (in sphere of radius *R*)

$$E_{tot} < \frac{c^4}{2\gamma} R \qquad \text{[23]}$$

which is more or less well known thing, and there somewhere is connection with Heisenberg uncertainty principle, and with expansion of the “universe”.

End of comment.

In the light of previous consideration we could define:
Electrical potential energy between two same charge *q* at mutual distance *r,* in gravitational field created by mass *M* at distance *R.*

$$W_e = W_{e_0}\sqrt{1-\frac{2\gamma M}{Rc^2}}$$

$$W_e = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r}\sqrt{1-\frac{2\gamma M}{Rc^2}} = mc^2$$

Similarly, precise equation for electrical potential energy:

$$\underline{W_e = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{R}\sqrt{1-\frac{2\gamma m}{Rc^2}} = mc^2}\,.$$

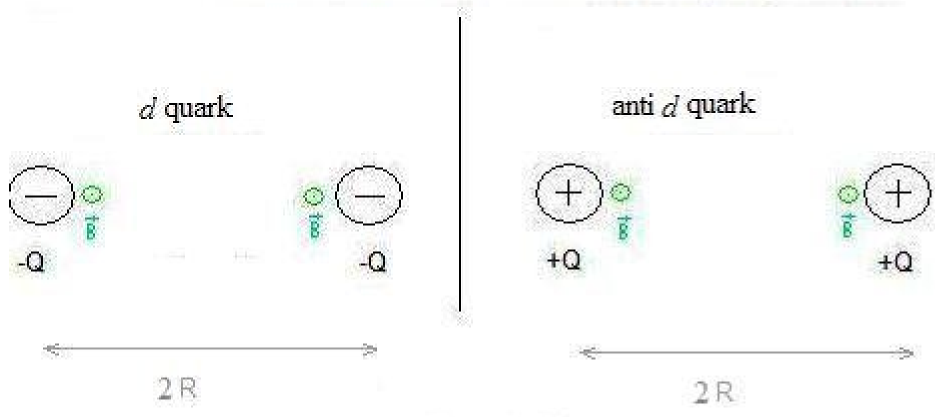
W_e Electrical potential energy of two same charge *q*, with combined mass *m,* at mutual distance *R*. [24]

[23] Even if we say “charge in point“or “mass of material point“ its physically impossible and useful mathematical tool.

[24] Equations are delivered from expression for total energy dissipation, so this equation is for that case. Total dissipation to the end, in one time direction, is particle creation in opposite time direction.

ASSESSMENT OF RADIUS *R*, OF THE *d* QUARK IN ELECTRON

For rough assessment which fallows, is worked under approximation $|\pm Q| >> |\pm q|$, and will calculate as if quark looks like as in picture below



$$Q = \frac{1}{6}e = \frac{1}{6}1{,}6 \cdot 10^{-19}c$$

1) If we assume that mass of one quark is measure of its electrical and magnetic potential energy.

$$m = \frac{W_e + W_m}{c^2}, W_e = W_m$$

And

$$W_e + W_m = 2W_e = mc^2$$

$$2\frac{1}{4\pi\varepsilon_0}\frac{q^2}{2R}\sqrt{1-\frac{2\gamma m}{Rc^2}} = mc^2$$

$$2\frac{1}{4 \cdot 3{,}14 \cdot 8{,}85 \cdot 10^{-12}}\frac{\left(\frac{1{,}6 \cdot 10^{-19}}{6}\right)^2}{2R}\sqrt{1-\frac{2 \cdot 6.673 \cdot 10^{-11} \cdot \frac{9{,}11 \cdot 10^{-31}}{3}}{R\left(3 \cdot 10^8\right)^2}} = \frac{9{,}11 \cdot 10^{-31}}{3}\left(3 \cdot 10^8\right)^2.$$

Solving equation we get three real solutions

$$R_1 \approx -2{,}34 \cdot 10^{-16}m$$
$$R_2 \approx 2{,}34 \cdot 10^{-16}m$$
$$R_3 \approx 4{,}50 \cdot 10^{-58}m.$$

First two solutions are interesting, and same as for classical calculation. Third solution is important for story about quark. For $R_3 \approx 4{,}50 \cdot 10^{-58} m$ relevant square root is very close to zero, but still **little more** then that.
Assessment of that **little more**

$$\sqrt{1-\frac{2 \cdot 6.673 \cdot 10^{-11} \cdot \frac{9{,}11 \cdot 10^{-31}}{3}}{R_3 \left(3 \cdot 10^8\right)^2}} \approx 1{,}9 \cdot 10^{-42}$$

which tell us

$$\sqrt{1-\frac{2\gamma M}{Rc^2}} \approx 0$$

i.e.

$R \approx \dfrac{2\gamma M}{c^2}$ hence very close to "Schwarzschild radius" (R_S) [25]

but something more then that.

$$\sqrt{1-\frac{2 \cdot 6.673 \cdot 10^{-11} \cdot \frac{9{,}11 \cdot 10^{-31}}{3}}{(R_S+\Delta R)\left(3 \cdot 10^8\right)^2}} \approx 1{,}9 \cdot 10^{-42}$$

$$\sqrt{1-\frac{2\gamma m}{(R_S+\Delta R)c^2}} \approx 1{,}9 \cdot 10^{-42}$$

$$\sqrt{1-\frac{2\gamma m}{c^2}\frac{1}{R_S}\frac{1}{\left(1+\frac{\Delta R}{R_S}\right)}} \approx 1{,}9 \cdot 10^{-42}, \frac{2\gamma m}{c^2}\frac{1}{R_S}=1$$

$$\sqrt{1-1\left(1-\frac{\Delta R}{R_S}-\ldots\right)} \approx 1{,}9 \cdot 10^{-42}$$

$$\sqrt{\frac{\Delta R}{R_S}} \approx 1{,}9 \cdot 10^{-42}$$

$$\frac{\Delta R}{R_S} \approx 3{,}6 \cdot 10^{-81}.$$

Relation between that **little more** and R_S. (I.e. quark radius $R = R_S + \Delta R$)
These are rough assessment. But what I try to show is:
- these constructions are possible
- it's very close to "Schwarzschild radius" (R_S)

[25] This is normal lengths, one meter is one meter, hence "...". Schwarzschild's are not, or so I heard.

Quark radius in electron

$$R \approx 4{,}50 \cdot 10^{-58}\, m\,.$$

2) Different approach, *d* quark radius in electron

Similar result could be gained by calculating radius of quark as it goes around himself on its on quark sphere.

Primary assumptions.
Quark is self entangled by its on gravitational field. Its revolves around itself. It is very similar to photon, locally it is the plane wave which is moving at speed of light. So motion of quark around itself can be observed almost as motion of one photon on its own photon sphere.[26] In that case relevant equations are:

$$E = mc^2 = h\nu = h\frac{c}{\lambda} = h\frac{c}{2R\pi}$$

h local value of the Planck constant
R radius of the quark sphere (circle)
λ wave length[27]

and

$$h = \sqrt{\frac{1-\sqrt{\frac{2\gamma m}{Rc^2}}}{1+\sqrt{\frac{2\gamma m}{Rc^2}}}}\,h_0\,.$$

Combining last two equations

$$h = mc2R\pi = \sqrt{\frac{1-\sqrt{\frac{2\gamma m}{Rc^2}}}{1+\sqrt{\frac{2\gamma m}{Rc^2}}}}\,h_0$$

$$mR2\cdot 3\cdot 10^8 \cdot 3{,}14 = \sqrt{\frac{1-\sqrt{\frac{2\cdot 6{,}673\cdot 10^{-11}}{\left(3\cdot 10^8\right)^2}\frac{m}{R}}}{1+\sqrt{\frac{2\cdot 6{,}673\cdot 10^{-11}}{\left(3\cdot 10^8\right)^2}\frac{m}{R}}}}\,6{,}626\cdot 10^{-34}$$

[26] Probably more like some kind of ellipsoid .
[27] Trivial calculation will give, interesting result, that for these constructions energy increases with increase of wave length (i.e. quark radius).

for, $m = \frac{9{,}11 \cdot 10^{-31}}{3} kg$ (mass of one d quark in electron).

Solving equation gives three real solutions:

$R_1 \approx -1{,}16 \cdot 10^{-12} m$
$R_2 \approx 1{,}16 \cdot 10^{-12} m$
$R_3 \approx 4{,}50 \cdot 10^{-58} m$.
Solution of importance for quark is $R_3 \approx 4{,}50 \cdot 10^{-58} m$ ... as is before. [28]

3) Or simply assessment of quark radius can be find using equation on page 14

$$R \approx \frac{2\gamma m}{c^2}\left(1 + \frac{m^2}{m_0^2} + \dots\right), \ \frac{m^2}{m_0^2} << 1$$

i.e.

For great mass defect… radius is very close but still little bit bigger then "Schwarzschild radius". [29]

$$R \approx \frac{2\gamma m}{c^2}$$

$$R \approx \frac{2\gamma m}{c^2} \approx \frac{2 \cdot 6{,}673 \cdot 10^{-11} \frac{9{,}11 \cdot 10^{-31}}{3}}{\left(3 \cdot 10^8\right)^2}$$

$$R \approx 4.5 \cdot 10^{-58} m .$$

Identical calculation which holds for d also holds for $\tilde{d}$.

[28] Even if concurrence of results is "good" that does not have to mean that calculations are correct, because basically they are the same one.
[29] Again, **it's not** real "Schwarzschild radius". Space is not costricting, objects are. Or better, even **if** space changes, that change nothing .

d and $\widetilde{d}$ in different situations

	d quark in electron	$\widetilde{d}$ quark in up quark	d quark „free“ in proton (neutron)
mass $m[kg]$	$3{,}037 \cdot 10^{-31}$	$2{,}783 \cdot 10^{-28}$	$5{,}567 \cdot 10^{-28}$
radius $R[m]$ $R \approx \frac{2\gamma m}{c^2}$	$4{,}5 \cdot 10^{-58}$	$4{,}1 \cdot 10^{-55}$	$8{,}3 \cdot 10^{-55}$

GENERAL CONCLUSIONS
And some speculations

1. If mass is only difference between two quark, then we don't have two different quark. We have same one with different mass (different potential energy)…
2. There is not one region in space from which photon, directed strictly away from it, can't escape.
3. "Background radiation" is not picture of early "universe", rather is picture of old photon sphere[30], but there is no proof for that either.
4. These thing that we name "universe" is just a part of larger and this ours takes energy-mass from neighbor, hence its growth, that doesn't mean that it was always grown, or that it will always grow. While our neighbor feed us we will grow if he stops, our growth will stop. Look at, $E_{tot} < \frac{c^4}{2\gamma} R$.
5. Maybe there was "big beng", but "universe expansion" and "background radiation" is not valid proof for that.
6. Particle measuring, in some way, mean compressing it, and is not possible to compress it under certain radius (if its hold on to its energy). It will escape from there or disappear there and appear next to it[31] . It may seams strange but is simple.
7. Same thing which is cause to Heisenberg uncertainty principle is causing universe expansion and that is, in a way, limit to energy density.
8. Three quark in electron, and similar constructions, are not like three nails hammered in plank of wood.

[30] Which was and still is
[31] Obeying the lows of conservation and not moving faster then light…

…

I'm aware that lots of these statements are like „water is wet", but its need to be said.

THE END

ADDITIONS

ADDITION [1]

1)

$$\frac{1}{T}=\frac{1}{T_0}\sqrt{1-\frac{2\gamma\cdot M}{Rc^2}}$$ Why this equation?

In compliance to special theory of relativity, time interval between two events…is

$$T=\frac{T_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

v – Speed of system, where time interval is T, relative to the system in which same interval is T_0.

There is certain equivalence between accelerated motion in space where is no gravitational field, and resting [32] in space where gravitational field exists.

Free-fall in gravitational field **DOES NOT** implies relativistic mass gain.

Body under gravitational free-fall **LOSES** part of its mass (lost mass goes to speed increase of the mass that remain). Energy is conserved.

In any case same body have lesser mass "down" then "up", either that body is in free-fall or someone is lowering it down…

When we separating two bodies, even if it is with constant speed, then we increasing their masses…

Man lifting the object, with constant speed along the whole way, of 1 kg on height of 1m, near surface of the Earth, has to do equivalent work, as if somewhere outside gravitational field to object of 1 kg gives acceleration of 9,81 $\frac{m}{s^2}$ (i.e. exerting the force of 9,81 N on object) along the way of 1 m.

Mass increase is the same in both cases.

[32] Or moving with constant speed.

So it follows

$$T = \frac{T_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\frac{1}{T} = \frac{1}{T_0}\sqrt{1 - \frac{v^2}{c^2}}$$

v speed of the body in free-fall (or not fall), in gravitational field

$$\frac{1}{T} = \frac{1}{T_0}\sqrt{1 - \frac{2gR}{c^2}}$$

g acceleration, but not for all. Equations will correct our assumption, we simple define "alphabet" that we need to express. That g is for weak fields, general solutions will be similar.

$$\frac{1}{T} = \frac{1}{T_0}\sqrt{1 - \frac{2\gamma MR}{R^2 c^2}}$$

$$\frac{1}{T} = \frac{1}{T_0}\sqrt{1 - \frac{2\gamma M}{R\ c^2}}$$

ADDITION [2]

2) A few concrete examples of mass change in weak gravitational field, and comparison of two approaches.

1) "Classical", mass change caused by exerted work in gravitational field.
2) "Relativistic", mass change caused by change of basic frequency of quantum oscillator, which is caused by different time flow in gravitational field.

1) Classical approach

At the Earth surface measured mass of one weight is *m=1kg,* what is its mass at height:
a) *h =100 m* above Earth surface (*g=9,81 m/s²)*
b) *h=200 km* above earth surface
c) *H=35786 km*

Answer:

All energy used to lift the body goes to body mass increase [33]

a) $m = 1kg, g = 9{,}81\dfrac{m}{s^2}, h = 100m$

$$A = mgh = 1 \cdot 9{,}81 \cdot 100 = 981J$$
$$A = \Delta mc^2 = (m_{100} - m)c^2$$
$$m_{100} = m + \frac{A}{c^2}$$
$$m_{100} = 1kg + \frac{981}{(3 \cdot 10^8)^2}$$
$$m_{100} = 1 + 1{,}09 \cdot 10^{-14}\,kg$$

$m = 1kg$ mass of one weight on surface of the Earth
$m_{100} = 1 + 1{,}09 \cdot 10^{-14}\,kg$ mass of that same weight after it's lifted at height of 100 *m*.

Mass gain at that process

$$\Delta m = 1.09 \cdot 10^{-14}\,kg\ .$$

b) $m = 1kg, \gamma = 6.673 \cdot 10^{-11}\dfrac{m^3}{kgs^2}, M = 5.9742 \cdot 10^{24}, R = 6374790{,}804m, h = 200km$

$$A = \gamma Mm\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$$
$$A = 6{,}673 \cdot 10^{-11} \cdot 5{,}9742 \cdot 10^{24} \cdot 1 \cdot \left(\frac{1}{6374790{,}804} - \frac{1}{6374790{,}804 + 200000}\right)$$
$$A = 1902317{,}493\,J$$

[33] During lifting process mass of weight is changing. Even if that minor change is cause of attraction…we do not calculate it, in process of lifting. I.e. During calculation of work needed to lift object in weak fields we calculate as if mass is constant.

$$m_H = m + \frac{A}{c^2}$$
$$m_{200k} = 1 + \frac{1902317{,}493}{\left(3\cdot 10^8\right)^2}$$
$$m_{200k} = 1 + 2{,}1137\cdot 10^{-11}\ kg$$

$m = 1kg$ mass of one weight on surface of the Earth
$m_{200k} = 1 + 2{,}1137\cdot 10^{-11}\ kg$ mass of that same weight after its lifted at height of 200 *km*.

Mass gain at that process

$$\Delta m = 2{,}1137\cdot 10^{-11} kg\ .$$

c) Mass change caused by elevating it at height of geostationary orbit
$m = 1kg, \gamma = 6.673\cdot 10^{-11}\,\frac{m^3}{kgs^2}, M = 5.9742\cdot 10^{24}, R = 6374790{,}804m, H = 35786km$.

$$A = \gamma Mm\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$$
$$A = 6{,}673\cdot 10^{-11}\cdot 5{,}9742\cdot 10^{24}\cdot 1\cdot\left(\frac{1}{6374790{,}804} - \frac{1}{6374790{,}804 + 35786000}\right)$$
$$A = 53081031{,}56\ J$$
$$m_H = 1 + \frac{53081031{,}56}{\left(3\cdot 10^8\right)^2}$$
$$m_H = 1 + 5{,}898\cdot 10^{-10}\ kg.$$

Mass gain at that process

$$\Delta m = 5{,}898\cdot 10^{-10} kg\ .$$

2) Relativistic approach

First is calculation for time change in gravitational field, then energy change and mass change.

$$T = \frac{T_0}{\sqrt{1 - \frac{2\gamma M}{Rc^2}}},$$ [34]

$$T \approx \frac{T_0}{\sqrt{1 - \frac{8{,}859 \cdot 10^{-3}}{R}}}$$, series expansion

$$T \approx T_0\left(1 + \frac{1}{2}\left(\frac{8{,}859 \cdot 10^{-3}}{R}\right) + \frac{3}{8}\left(\frac{8{,}859 \cdot 10^{-3}}{R}\right)^2 + ...\right)$$

$$T \approx T_0\left(1 + 4{,}4295 \cdot 10^{-3}\,\frac{1}{R}\right).$$

Let's define ***T₀* =1*s***

then, on surface of the Earth:

$$T_E = 1 \cdot \left(1 + 4{,}4295 \cdot 10^{-3}\,\frac{1}{6374790{,}804}\right)$$

$$\underbrace{1s}_{T_0} + \underbrace{6{,}948 \cdot 10^{-10}\,s}_{\Delta T_0}$$

$$T_E = 1s + 6{,}948 \cdot 10^{-10}\,s$$

$T_E = T_0 + \Delta T_0$

T_E duration of time interval on Earth surface
T_0 duration of time interval outside gravitational field
ΔT_0 change to duration of time interval at Earth surface.

[34] T is functional dependence to time interval of ratio $\frac{M}{R}$, when $\frac{M}{R} \to 0$, $T = T_0$ there where is no gravitational field tact exist and there is shortest i.e. $T_{0\ min}$. Wherever gravitational field exist there is $T > T_0$.

I) For T_0 = 1*s*, find T on different heights:

a) 100 *m*
b) 200 *km*
c) 35786 *km*

a) 100 *m*

$$T_{100} = 1 + 4{,}4295 \cdot 10^{-3} \cdot 1 \cdot \frac{1}{6374790{,}804 + 100}$$

$$T_{100} = 1 + 4{,}4295 \cdot 10^{-3} \frac{1}{6374790{,}804} \frac{1}{1 + \dfrac{100}{6374790{,}804}}$$

$$T_{100} \approx \overset{T_0}{1} + \overset{\Delta T_0}{6{,}948 \cdot 10^{-10}} - \overset{\Delta T_{100}}{6{,}948 \cdot 10^{-10} \cdot 1{,}57 \cdot 10^{-5}}$$

$T_{100} = T_0 + \Delta T_0 + \Delta T_{100}$

T_{100} duration of time interval at a height of 100 *m*
T_0 duration of time interval outside gravitational field
ΔT_0 change to duration of time interval at Earth surface
ΔT_{100} change to duration of time interval at a height of 100 *m*.

b) 200 *km*

$$T_{200k} = 1 + 4{,}4295 \cdot 10^{-3} \cdot 1 \cdot \frac{1}{6374790{,}804 + 200000}$$

$$T_{200k} = 1 + 6{,}948 \cdot 10^{-10} - 6{,}948 \cdot 10^{-10} \cdot 0{,}0304$$

$$T_{200k} = T_0 + \Delta T - \Delta T_{200k}$$

c) 35786000 *m*

$$T_{36m} = 1 + 4{,}4295 \cdot 10^{-3} \cdot 1 \cdot \frac{1}{6374790{,}804 + 35786000}$$

$$T_{36m} = 1 + 6{,}948 \cdot 10^{-10} - 6{,}948 \cdot 10^{-10} \cdot 0{,}8488$$

$$T_{36m} = T_0 + \Delta T - \Delta T_{36m}\,.$$

II) How does change of time interval in gravitational field affect energy (mass) of oscillators. Concretely how much potential energy (mass) does change at heights:

a) 100 *m*
b) 200 *km*
c) 35786 *km*

$E = \frac{\hbar\pi}{T}$ basic energy of quantum oscillator

$E_E = \frac{\hbar\pi}{T_E}$ basic energy of same quantum oscillator at Earth surface

$$E_E = \frac{\hbar\pi}{T_E} = \frac{1{,}0546 \cdot 10^{-34} \cdot 3{,}14}{1 + 6{,}948 \cdot 10^{-10}}$$
$$E_E = 3{,}31 \cdot 10^{-34}\, J.$$

a) Energy of same quantum oscillator elevated at 100 *m*.

$$E_{100} = \frac{\hbar\pi}{T_{100}} = \frac{1{,}0546 \cdot 10^{-34} \cdot 3{,}14}{1 + 6{,}948 \cdot 10^{-10} - 6{,}948 \cdot 10^{-10} \cdot 1{,}57 \cdot 10^{-5}}$$
$$E_{100} = \frac{1{,}0546 \cdot 10^{-34} \cdot 3{,}14}{1 + 6{,}948 \cdot 10^{-10}} \frac{1}{1 - \frac{6{,}948 \cdot 10^{-10} \cdot 1{,}57 \cdot 10^{-5}}{1 + 6{,}948 \cdot 10^{-10}}}$$
$$E_{100} = 3{,}31 \cdot 10^{-34} \frac{1}{1 - 1{,}09 \cdot 10^{-14}}$$, series expansion
$$E_{100} \approx 3{,}31 \cdot 10^{-34} \cdot \left(1 + 1{,}09 \cdot 10^{-14} + \ldots\right)$$

$$E_{100} = E_E \cdot \left(1 + 1{,}09 \cdot 10^{-14}\right)$$
$$E_{100} - E_E = E_E\, 1{,}09 \cdot 10^{-14}$$

$$\Delta E = E_{100} - E_E$$
$$\Delta mc^2 = mc^2\, 1{,}09 \cdot 10^{-14}$$
$$\Delta m = m\, 1{,}09 \cdot 10^{-14}$$
for $m = 1\ kg$
$$\Delta m = 1{,}09 \cdot 10^{-14}\, kg$$
compare with the previous calculations
($\Delta m = 1.09 \cdot 10^{-14}\, kg$).

b) Energy of same quantum oscillator elevated at 200 *km*.

$$E_{200k} = \frac{\hbar\pi}{T_{200k}} = \frac{1{,}0546\cdot 10^{-34}\cdot 3{,}14}{1+6{,}948\cdot 10^{-10} - 6{,}948\cdot 10^{-10}\cdot 0{,}0304}$$

$$E_{200k} = \frac{1{,}0546\cdot 10^{-34}\cdot 3{,}14}{1+6{,}948\cdot 10^{-10}}\frac{1}{1-\dfrac{6{,}948\cdot 10^{-10}\cdot 0{,}0304}{1+6{,}948\cdot 10^{-10}}}$$

$$E_{200k} = 3{,}31\cdot 10^{-34}\frac{1}{1-2{,}112\cdot 10^{-11}}\text{, series expansion}$$

$$E_{200k} \approx 3{,}31\cdot 10^{-34}\left(1+2{,}112\cdot 10^{-11}+...\right)$$

$$E_{200k} = E_E\left(1+2{,}112\cdot 10^{-11}\right)$$

$$E_{200k} - E_E = E_E\ 2{,}112\cdot 10^{-11}$$

$\Delta mc^2 = mc^2\, 2{,}112\cdot 10^{-11}$

$\Delta m = m\, 2{,}112\cdot 10^{-11}$

For $m=1kg$

$$\Delta m = 2{,}112\cdot 10^{-11}\,kg$$

compare with the previous calculations ($\Delta m = 2{,}1137\cdot 10^{-11}\,kg$).

c) Potential energy (mass) for same quantum oscillator at distance of geostationary orbit, 35786 *km*

$$E_{35786k} = \frac{\hbar\pi}{T_{35786k}} = \frac{1{,}0546\cdot 10^{-34}\cdot 3{,}14}{1+6{,}948\cdot 10^{-10} - 6{,}948\cdot 10^{-10}\cdot 0{,}8488}$$

$$E_{35786k} = 3{,}31\cdot 10^{-34}\frac{1}{1-5{,}897\cdot 10^{-10}}\text{, series expansion}$$

$$E_{35786k} \approx 3{,}31\cdot 10^{-34}\left(1+5{,}897\cdot 10^{-10}\right)...$$

$\Delta m = m\cdot 5{,}987\cdot 10^{-10}$

for $m=1kg$

$$\Delta m = 5{,}987\cdot 10^{-10}\,kg$$

compare with the previous calculations ($\Delta m = 5{,}898\cdot 10^{-10}\,kg$).

Results show good correlation with classical calculation, which implies that:
1) There is gravitational mass defect.
2) Mass defect is caused by different time flow at different places in gravitational field.
3)…

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