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# Shielding of Gravitational Field in Space

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## Perspective

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### ABSTRACT

The study presents a model of shielding gravitational field proton space. Screening of gravitation based on the principle: elementary particle with the rest mass and which are in free fall escapes all gravitational fields in which it is located. In the present work the strength of the gravitational field of an infinite half-space is determined. Defined cross-section of proton escapes the gravitational field. Calculated radius of action of gravitational forces in space. We obtain a formula for determining the distance to the galaxy by its «red» offset. The researchers calculated the life time of a photon in space, determining the size of the horizon of the Universe.

## THE BASIC PART

We calculate the strength of gravitational field of an infinite half-space. Let the density of matter in space be n protons in a unit volume. A material point of mass m is situated at the beginning of the spherical coordinate system as shown in **Figure 1**. Half-space is limited to the plane of XY and endlessly along the Z-axis.

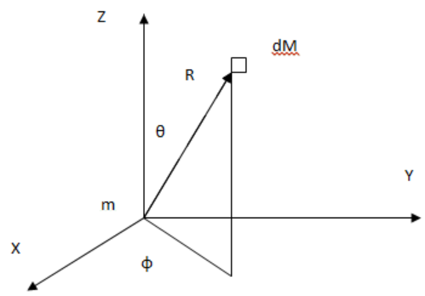


**Figure 1.** Location of object at spherical coordinate system.

Item volume of this half-space in a spherical coordinate system $dV = R^2 \sin\theta d\theta d\phi dR$

Weight in this volume $dM = \rho dV$

Where, ρ is the average density of matter in space (n-protons in a unit of volume).

Mass dM acts on being in the beginning of the coordinates of a point mass m with the power $dF = \frac{\gamma m dM}{R^2}$

Component of the force along the axis Z is equal

$$dF = \frac{\gamma m dM}{R^2} cos\theta \quad \text{or} \quad dF = \gamma m \rho \cos\theta \sin\theta d\theta d\phi dR$$

The force acting on the mass m from the side of the half-space is equal to

$F = \gamma m\rho \int \sin\theta \cos\theta d\theta d\phi dR$ denote $J = \int \sin\theta \cos\theta d\theta \int d\phi \int dR$

Where, $0 \le \theta \le \pi/2;\ 0 \le \phi \le 2\pi;\ 0 \le R < \infty;\ \pi = 3.14$

To resolve the divergence of the integral, applicable shielding action space particles in gravitational field, the force exerted by the element dM on the mass m will be eased space particles located in a solid angle dω, which is visible volume element dV from the origin of coordinates. Size of the dS which is based solid angle dω equal:

$dS = R^2 \sin\theta d\theta d\phi$

The volume of the solid angle of the cone is equal to $dV = \dfrac{1}{3} RdS$

Number of particles in a volume equal to $dN = \dfrac{1}{3} nR\ dS$ or $dN = \dfrac{1}{3} nR^3\ \sin\theta d\theta d\phi$

The area of overlap protons space within the solid angle dω equal $dS_o = \sigma dN$

Where, σ is the cross-section of proton fully escapes the gravitational field.

Substitute dN this expression get $dS_o = \dfrac{1}{3}\sigma n R^3 \sin\theta d\theta d\phi$

We introduce shielding rate $k = \dfrac{dS_o}{dS}$ or $k = \dfrac{1}{3} n\sigma R$ When k=1 we obtain $R_o = \dfrac{3}{n\sigma}$

Particle m will be fully provided at the distance $R = R_o$. From protons located at a distance greater than $R_o$. We write the integral as $J = \int \sin\theta \cos\theta d\theta \int d\phi \int kdR$

Where, $0 \le \theta \le \pi/2;\ 0 \le \phi \le 2\pi;\ 0 \le R \le R_o$

Obtain $J = \dfrac{\pi}{6} n\sigma R^2$

The force acting on the particle m from the side of the half-space is equal to $F = \dfrac{3}{2}\dfrac{\pi\gamma m\rho}{n\sigma}$ Express density ρ through the mass of a proton Mp . We obtain $\rho = nM_p$ Then, $F = \dfrac{3}{2}\dfrac{\pi\gamma M_p}{\sigma}$ Strength of gravitational field of a half space $g = \dfrac{F}{m}$.

$$g = \frac{3}{2}\frac{\pi\gamma M_p}{\sigma} \quad (1)$$

Count the loss of photon energy as it propagates in space. Let at the moment of time t=0
Source A yielded up the photon frequency v direction AB as shown in **Figure 2**. Divide the plane containing line segment AB all the space on two half-space left and right. Mentally destroy in the left half-space all the cosmic substance. We introduce the rectangular system of coordinates. Z-axis is perpendicular to the plane containing line segment AB. The X axis is directed along the line segment AB.

Under the action of gravity of the substance of the right half-space. The trajectory of a photon deviates from the line AB to the right half-space. Photon gain momentum along the positive direction of the Z-axis. The substance of the right half-space will begin to move in the direction of the photon trajectory. If both half-spaces will be filled with substance, the trajectory of a photon is a straight line AB. Substance in the volume of the cylinder of radius $R_o$ starts to move toward the trajectory of the photon. The energy of a photon will be spent on setting in motion the substance of the cosmos to the photon trajectory. The kinetic energy acquired the substance of the cosmos will be equal to the loss of energy of the photon. Photon frequency will decrease. We calculate the decrease in the energy of a photon on a trajectory segment of length L. Let, the moment of emission of a photon t=0 its energy $\varepsilon = h\nu$. Through time ∆t energy of a photon will $\varepsilon^1 = h\nu^1$. Consider the transverse motion of the photon along the Z-axis. Under the action of gravity of the right half-filled substance the cosmos, at the end of its trajectory at point B, the photon gets cross V velocity is directed along the Z-axis. For the transverse motion of photon, the dependence of its mass from the speed of its transverse motion will be

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

Where, m is the mass of a photon at the time of its emission;
$m_1$ is the mass of a photon through time Δt after the date of its emission;
c is the velocity of light in vacuum.

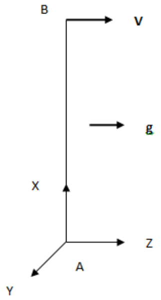


**Figure 2.** Source A yielding up the photon frequency v direction AB.

In the end of the trajectory at point B, the Energy of a photon is increased by the value.

$$\Delta\varepsilon = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}} - mc^2$$

Transverse speed of a photon V, in the point B is determined from the equality:

$$V = gt = g\frac{L}{c}$$

Where, g is the gravitational field strength from the right half-space. If all space is filled with substance, the decrease of the energy of a photon on the trajectory AB=L is equal to $2\Delta\varepsilon$

$$h\nu - h\nu^1 = 2h\nu\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - 1\right)$$

Here,

$$\frac{v}{c} = \frac{\sqrt{1+\frac{\Delta\nu}{4\nu}}}{1+\frac{\Delta\nu}{2\nu}}\sqrt{\frac{\Delta\nu}{\nu}} \quad (2)$$

Use «red» shift of the emission spectra of distant galaxies.

$$z = \frac{\lambda^1 - \lambda}{\lambda}$$

Where, λ is the wavelength of the emitted photon;
λ1 is the wavelength the observed photon.

Then $z = \frac{\nu}{\nu^1} - 1$ here $\frac{\Delta\nu}{\nu} = \frac{z}{z+1}$

Let's substitute the formula (2) the expression for the $\frac{\Delta\nu}{\nu}$ get

$$\frac{V}{c} = \frac{\sqrt{z(5z+4)}}{3z+2}$$

Substitute $V = g\frac{L}{c}$ we obtain $\frac{3}{2}\frac{\pi\gamma\rho L}{n\sigma c^2} = \frac{\sqrt{z(5z+4)}}{3z+2}$

Substitute $\rho = nM_p$ we obtain $\sigma = \frac{3}{2}\frac{\pi\gamma LM_p}{c^2}\frac{(3z+2)}{\sqrt{z(5z+4)}}$ (3)

From astronomical observations take the value of «red» shift and z the distance to the galaxy L. Then according to formula (3) can be found cross-section of proton completely shielding gravitational field. For z =0.005 and L=0.493·1024m. We obtain σ =0.4·10-28m2. The cross section diameter of the shielding of the gravitational field of a proton is equal to d =7.2·10-15m. Imagine z as a function of L. We introduce the designation

$$\alpha = \frac{3}{2}\frac{\pi\gamma M_p}{\sigma c^2}$$

From the formula (3) gives a quadratic equation:

$$(9\alpha^2 L^2 - 5)z^2 + (12\alpha^2 L^2 - 4)z + 4\alpha^2 L = 0$$

From the condition z=0 when L=0 the quadratic equation has a unique root

$$z = \frac{2(1 - 3\alpha^2 L^2 - \sqrt{1 - \alpha^2 L^2})}{9\alpha^2 L^2 - 5} \quad (4)$$

From (4) we get, 0≤α2L2≤1 .

The denominator is zero when, $\alpha^2 L^2 = \frac{5}{9}$.

Hence $L = \frac{\sqrt{5}}{3\alpha}$ is the point of the gap for the function z =z (L).

Beyond right and left of the breaking point z has the value $\pm\infty$.

Substitute α in the expression $L = \frac{\sqrt{5}}{3\alpha}$.

Get horizon of the Universe L= 0.5·1025m. Knowing the red shift of galaxies you can calculate the distance to the galaxy by the formula

$$L = \frac{2}{3}\frac{\sigma c^2}{\pi\gamma M_p}\frac{\sqrt{z(5z+4)}}{3z+2} \quad (5)$$

Life time of a photon in space, $\mathrm{T}_p = \frac{2}{9}\frac{\sigma c\sqrt{5}}{\pi\gamma M_p}$ (6)

Horizon of the Universe $\mathrm{L}_h = \frac{2}{9}\frac{\sigma c\sqrt{5}}{\pi\gamma M_p}$ (7)

## CONCLUSION

The Possibility of gravitational field shielding allows experimental distinguishing of the gravitational field of acceleration. Shielding of the gravitational field can be detected experimentally on installation as shown in **Figure 3**. Let M is lead cylinder, P as precision scales, m weight hanging on the scales. At the moment of the beginning of the fall of the cylinder M Scales P should reduce the indications.

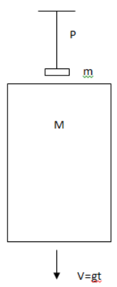


**Figure 3.** Experimental set up to determine shielding of gravitational field.