Black Hole Universe and the Earth's Gravity Field

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Abstract

Significant differences regarding the properties of the Earth's gravitational field and the gravitational field of the Black Hole Universe are presented.

Keywords: Schwarzschild metric, metric of the Black Hole Universe, photon energy, redshift, Hubble's constant.

1. Introduction

In the dissertation [1] I proposed a black-hole model of the Universe. Our Universe can be treated as a gigantic homogeneous Black Hole with an anti-gravity shell. Our Galaxy, together with the solar system and the Earth, which in the cosmological scale can be considered only as a point, should be located near the center of the Black Hole Universe.

In the following part of this work we will present significant differences regarding the properties of the Earth's gravitational field and the gravitational field of the Black Hole Universe. We will find out at what distance from the center of Our Universe there should be a given light source to emit photons with the same energy as an identical source located on the surface of the Earth. We will also find out at what distance from the Earth its gravitational field is such as the gravitational field of the Universe.

2. Earth's gravitational field

The stationary gravitational field of the Earth can be described in the first approximation with an external Schwarzschild metric

$$(ds)^2 = \left(1-\frac{r_S}{r}\right)^{-1}(dr)^2 + r^2(d\theta)^2 + r^2\sin^2\theta\,(d\varphi)^2 + \left(1-\frac{r_S}{r}\right)(dict)^2, \quad r_S = \frac{2GM_E}{c^2}$$

where

r_S – Schwarzschild radius for the Earth
r – distance from the center of the Earth
G – gravitational constant
M_E – mass of the Earth
c – standard value of the speed of light

3. Gravitational field of the Black Hole Universe

The spacetime metric of the Black Hole Universe [1] is given by:

$$(ds)^2 = \left(1 - \frac{r^2}{R^2}\right)^{-1} (dr)^2 + r^2 (d\theta)^2 + r^2 \sin^2\theta\, (d\varphi)^2 + \left(1 - \frac{r^2}{R^2}\right) (dict)^2, \quad 0 \le r < R$$

where

r – distance from the center of the Black Hole Universe
R – radius of the Black Hole Universe

4. Influence of the gravitational field on spatial and temporal distance

The gravitational fields we study can be unambiguously characterized by the time-time component (g_{44}) of the metric tensor.

At sufficiently large distances from the center of Our Universe spacetime metric

$$(g_{44})_{Universe} = \left(1 - \frac{r^2}{R^2}\right)_{Universe}$$

has a different form than locally near the Earth

$$(g_{44})_{Earth} = \left(1 - \frac{r_S}{r}\right)_{Earth} .$$

The above formulas show that:
1. On a scale of cosmological distances, the farther from the Earth, the more gravitational field is stronger. Locally, near the Earth, we observe the opposite situation.

2. The spatial distance between two closely located events is the greater, the stronger the gravitational field.

$r \downarrow \Rightarrow (g_{11})_{Earth} (dr)^2 \uparrow$	$r \uparrow \Rightarrow (g_{11})_{Universe} (dr)^2 \uparrow$	$(g_{11}) = (g_{44})^{-1}$

This phenomenon can be called a *gravitational dilation of spatial distance*.

3. The time distance between two closely located events is the smaller the stronger the gravitational field.

$r \downarrow \Rightarrow (g_{44})_{Earth} (cdt)^2 \downarrow$	$r \uparrow \Rightarrow (g_{44})_{Universe} (cdt)^2 \downarrow$

This phenomenon can be called *gravitational contraction of temporal distance*.

5. Redshift of light reaching the Earth from the Sun

The definition of redshift (z*) comes from work [1].

$$z^{*} \overset{df}{=} \frac{E_{lab}}{E_{out}} - 1 = \frac{\sqrt{g_{44}^{lab}}}{\sqrt{g_{44}^{out}}} - 1$$

$$E_{lab} = E_{max}\sqrt{g_{44}^{lab}}\,, \quad E_{out} = E_{max}\sqrt{g_{44}^{out}}$$

$$g_{44}^{lab} = 1 - \frac{2GM_E}{c^2R_E}\,, \quad g_{44}^{out} = 1 - \frac{2GM_S}{c^2R_S}\,, \quad g_{44}^{lab} = \left(g_{11}^{lab}\right)^{-1}, \quad g_{44}^{out} = \left(g_{11}^{out}\right)^{-1}$$

$$\left(\frac{2GM_E}{c^2R_E}\right) \approx 1.4\cdot 10^{-9}\,, \quad \left(\frac{2GM_S}{c^2R_S}\right) \approx 4.3\cdot 10^{-6}$$

$$z^{*} \approx \frac{1}{2}\left(\frac{2GM_S}{c^2R_S}\right) - \frac{1}{2}\left(\frac{2GM_E}{c^2R_E}\right) - \frac{1}{4}\left(\frac{2GM_S}{c^2R_S}\right)\left(\frac{2GM_E}{c^2R_E}\right) + \frac{1}{4}\left(\frac{2GM_S}{c^2R_S}\right)\left(\frac{2GM_S}{c^2R_S}\right) \approx 2.15\cdot 10^{-6}$$

E_{lab} – photon energy emitted from a source in the laboratory
E_{out} – photon energy emitted from a source outside the laboratory
E_{max} – photon energy emitted in the absence of a gravitational field
g_{44}^{lab} – component of the metric tensor in the laboratory at the photon detection location
g_{44}^{out} – component of the metric tensor outside the laboratory at the photon emission site
M_S – mass of the Sun
M_E – mass of the Earth
R_S – radius of the Sun
R_E – radius of the Earth

Redshift of sunlight is a local effect, therefore for the components of the metric tensor we used the formulas proper to the external Schwarzschild metric dependent on the local source masses and their sizes. In addition, we have assumed that the light source is located on the surface of the Sun or Earth, respectively.

6. Redshift of light reaching the Earth from a distant galaxy

$$z^{*} = \frac{\sqrt{g_{44}^{lab}}}{\sqrt{g_{44}^{out}}} - 1$$

$$g_{44}^{lab} = \left(1 - \frac{2GM_E}{c^2R_E}\right) \approx 1 - 1.4\cdot 10^{-9}$$

$$g_{44}^{out} = 1 - \frac{r^2}{R^2}$$

$$z^{*} = \frac{\sqrt{1 - \left(\frac{2GM_E}{c^2R_E}\right)}}{\sqrt{1 - \frac{r^2}{R^2}}} - 1 \approx \frac{\sqrt{1 - 1.4\cdot 10^{-9}}}{\sqrt{1 - \frac{r^2}{R^2}}} - 1$$

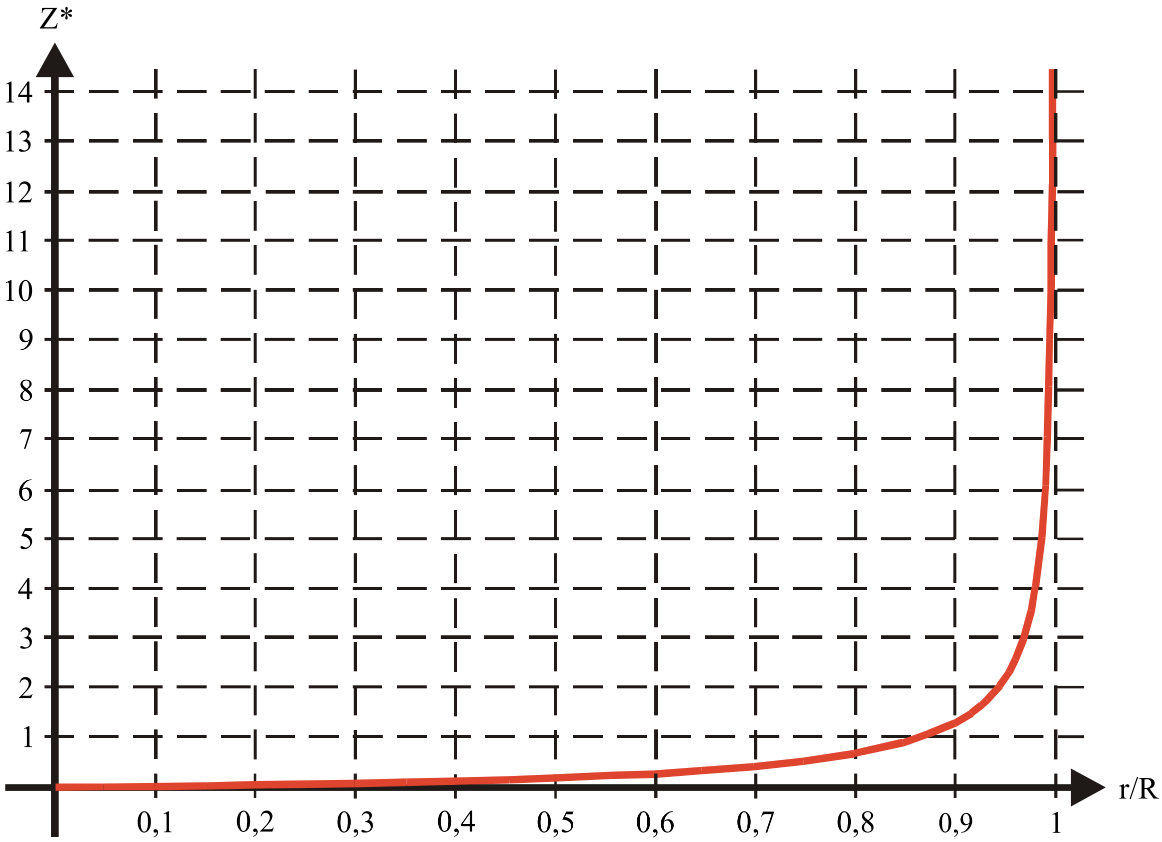

Diagram that shows dependence of redshift (z*) versus the distance (r) of the source from the center of Our Universe [1, 2], (R) is the radius of Our Universe. [Note: (z*) takes negative values for the ratio (r/R) of approximately less than 3.74 10^{-5}.]

We will determine at what distance (r_0) from the center of Our Universe there should be a given light source to emit photons with the same energy as an identical source located on the surface of the Earth. For this purpose, we compare the time-time components of metric tensors that characterize the gravitational fields of the Universe and the Earth, respectively.

$$1-\frac{r_0^2}{R^2}=1-\frac{r_S}{R_Z}$$

$$r_0=\sqrt{\frac{r_S}{R_Z}}\cdot R$$

$$\sqrt{\frac{r_S}{R_Z}}\approx 3.74\cdot 10^{-5}, \quad R\approx 0.6\cdot 10^{26}\,\mathrm{m}\ [1], \quad \text{light year}\approx 0.95\cdot 10^{16}\,\mathrm{m}$$

$$r_0\approx 2.245\cdot 10^{21}\,\mathrm{m}\approx 2.363\cdot 10^{5}\ \text{light years}=236{,}300\ \text{light years}$$

At a distance (r_0) from the center of Our Universe, the time-time component of the metric tensor is equal to the analogous component on the Earth's surface.

7. Free fall

Radial components of the acceleration of free fall in the Earth's gravitational field modeled by the Schwarzschild's external solution [3] and in the gravitational field of the Black Hole Universe [1] are given respectively by the following formulas:

$$a^{r}_{Earth} = -\frac{GM}{r^2} \cdot \frac{1}{\sqrt{1 - \frac{r_S}{r}}}$$

$$a^{r}_{Universe} = -\frac{c^2}{R^2} r \cdot \frac{1}{\sqrt{1 - \frac{r^2}{R^2}}}$$

By equating the right sides of both above equations, we will find out at what distance from the Earth its gravitational field is such as the gravitational field of the Universe.

$$r \approx \sqrt[3]{\frac{1}{2} \cdot r_S R^2} \approx 2.53 \cdot 10^{16} \text{m} \approx 2.67 \text{ light years}$$

8. Final remarks

The stronger the gravitational field, the more the space is stretched. For an observer on the Earth, the local space, with the increase in distance from the Earth, is becoming less and less stretched. In the cosmological scale we are dealing with a different situation, with the increase in distance from the Earth, space is becoming more stretched.

For the Hubble constant value being $H = 75\,\text{km} \cdot \text{s}^{-1} \cdot \text{Mpc}^{-1} \approx 2.43 \cdot 10^{-18} \text{s}^{-1}$ the radius (R) of Our Universe has the value [1]:

$$R \approx 0.6 \cdot 10^{26} \text{m} \approx 6.31 \text{ billion light years}$$

At the distance from the center of the Earth approximately equal to

$$r_0 \approx 2.245 \cdot 10^{21} \text{m} \approx 2.363 \cdot 10^5 \text{ light years} = 236{,}300 \text{ light years}$$

redshift (z*) measured relative to our planet changes sign from negative to positive.

The light reaching the Earth from Our Galaxy, whose radius is about 50,000 light years and the thickness of about 12,000 light years, should be shifted towards purple with respect to the light emitted on the Earth's surface.

References

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