Black Hole Universe and Einstein Space

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Abstract
Field equations modeling a black hole with maximal anti-gravity halo and Our Universe can be reduced to the form describing the so-called. Einstein space.

Keywords: Black Hole Universe, field equations, Einstein space, metric tensor, Ricci tensor.

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, field equations modeling a black hole with maximal anti-gravity halo and Our Universe will be brought to form describing the so-called. Einstein space.

2. Our Universe as Einstein space

Einstein gravitational field equations will be written in a classic form [2]:

$$\boxed{R_{\mu\nu} = \kappa\left(T_{\mu\nu} - \frac{1}{2} g_{\mu\nu} T\right)},$$

where

$$R_{\mu\nu} = \frac{\partial \Gamma^{\alpha}_{\mu\alpha}}{\partial x^{\nu}} - \frac{\partial \Gamma^{\alpha}_{\mu\nu}}{\partial x^{\alpha}} + \Gamma^{\beta}_{\mu\alpha}\Gamma^{\alpha}_{\beta\nu} - \Gamma^{\beta}_{\mu\nu}\Gamma^{\alpha}_{\beta\alpha}, \qquad \Gamma^{\alpha}_{\mu\nu} = \frac{1}{2} g^{\alpha\sigma}\left(\frac{\partial g_{\mu\sigma}}{\partial x^{\nu}} + \frac{\partial g_{\nu\sigma}}{\partial x^{\mu}} - \frac{\partial g_{\mu\nu}}{\partial x^{\sigma}}\right),$$

$$\kappa = \frac{8\pi G}{c^4} = 2{,}073 \cdot 10^{-43}\,\frac{s^2}{kg \cdot m}, \qquad T \overset{df}{=} g^{\alpha\beta} T_{\alpha\beta},$$

$$x^1 = r, \quad x^2 = \theta, \quad x^3 = \varphi, \quad x^4 = ict.$$

In the case where homogeneously distributed mass with constant density ρ in the ball area, is a source of stationary gravitational field, we postulate existence of the solution in the following form:

$$\boxed{(ds)^2 = g_{11}(dr)^2 + r^2(d\theta)^2 + r^2 \sin^2\theta\,(d\varphi)^2 + g_{44}(dx^4)^2},$$

$$g_{12} = g_{21} = g_{13} = g_{31} = g_{14} = g_{41} = g_{23} = g_{32} = g_{24} = g_{42} = g_{34} = g_{43} = 0,$$

$$g_{11} = \frac{1}{g_{44}}, \quad g_{22} = r^2, \quad g_{33} = r^2 \sin^2\theta, \quad g^{11} = \frac{1}{g_{11}}, \quad g^{22} = \frac{1}{g_{22}}, \quad g^{33} = \frac{1}{g_{33}}, \quad g^{44} = \frac{1}{g_{44}},$$

$$\boxed{T_{\alpha\beta} = \frac{1}{2}\rho c^2 g_{\alpha\beta}}, \quad \boxed{T \overset{\mathrm{df}}{=} g^{\alpha\beta} T_{\alpha\beta}}, \quad \boxed{\rho = \mathrm{const}},$$

$$T_{12} = T_{21} = T_{13} = T_{31} = T_{14} = T_{41} = T_{23} = T_{32} = T_{24} = T_{42} = T_{34} = T_{43} = 0,$$

$$T_{\alpha\alpha} = \frac{1}{2}\rho c^2 g_{\alpha\alpha}, \quad T = g^{\alpha\alpha} T_{\alpha\alpha} = 2\rho c^2, \quad T_{\alpha\alpha} - \frac{1}{2} g_{\alpha\alpha} T = -\frac{1}{2} g_{\alpha\alpha} \rho c^2.$$

Below will be given Ricci tensor components corresponding to the metric tensor components.

$$R_{12} = R_{21} = R_{13} = R_{31} = R_{14} = R_{41} = R_{23} = R_{32} = R_{24} = R_{42} = R_{34} = R_{43} = 0,$$

$$R_{11} = \frac{1}{g_{44}}\left(\frac{1}{r}\frac{\partial g_{44}}{\partial r} + \frac{1}{2}\frac{\partial^2 g_{44}}{\partial r^2}\right),$$

$$R_{22} = -1 + g_{44} + r\frac{\partial g_{44}}{\partial r},$$

$$R_{33} = \sin^2\theta\left(-1 + g_{44} + r\frac{\partial g_{44}}{\partial r}\right),$$

$$R_{44} = g_{44}\left(\frac{1}{r}\frac{\partial g_{44}}{\partial r} + \frac{1}{2}\frac{\partial^2 g_{44}}{\partial r^2}\right).$$

Taking into account the above relations, field equations can be finally saved in the form:

$$\boxed{R_{\alpha\alpha} = -\tfrac{1}{2}\rho c^2 \kappa g_{\alpha\alpha}, \quad R_{\mu\nu} = 0, \quad (\alpha, \mu, \nu = 1,2,3,4; \quad \mu \neq \nu), \quad \rho = \mathrm{const}}$$

Spacetime described by these equations, in which every component of Ricci tensor is proportional to adequate component of metric tensor is an Einstein space [3]. So spacetime of Our Universe is an Einstein space.

All mixed components of Ricci tensor are identically equal to zero. Set of remaining equations can be reduced to only two independent ones.

$$\boxed{\begin{aligned} R_{11} &= -\tfrac{1}{2}\rho c^2 \kappa g_{11} \\ R_{22} &= -\tfrac{1}{2}\rho c^2 \kappa g_{22} \end{aligned}} \Rightarrow \boxed{\begin{aligned} &\frac{1}{r}\frac{\partial g_{44}}{\partial r} + \frac{1}{2}\frac{\partial^2 g_{44}}{\partial r^2} = -\frac{1}{2}\kappa\rho c^2 \\ &-1 + g_{44} + r\frac{\partial g_{44}}{\partial r} = -\frac{1}{2}\kappa r^2 \rho c^2 \end{aligned}} \quad \boxed{\begin{aligned} &\frac{\partial g_{44}}{\partial r} + \frac{r}{2}\frac{\partial^2 g_{44}}{\partial r^2} = -\frac{1}{2}\kappa\rho c^2 r \\ &-1 + g_{44} + r\frac{\partial g_{44}}{\partial r} = -\frac{1}{2}\kappa r^2 \rho c^2 \end{aligned}}$$

These equations are fulfiled when

$$0 \le r < R, \quad \rho = \mathrm{const} > 0, \quad g_{44} = 1 - \frac{4\pi G\rho}{3c^2} r^2 = 1 - \frac{GM}{c^2 R^3} r^2 = 1 - \frac{r_S}{2R^3} r^2,$$

$$r \ge R, \quad \rho = 0, \quad g_{44} = 1 - \frac{2GM}{c^2 r} = 1 - \frac{r_S}{r}, \quad r \neq r_S.$$

$$M = \frac{4}{3}\pi\rho R^3$$

R – radius of the ball in which the source mass is located

$$r_S = \frac{2GM}{c^2}$$ – Schwarzschild radius

Presented equations model a black hole with maximal anti-gravity halo and Our Universe [1].

3. Final remarks

In order to build a model of Our Universe as a black hole with maximal anti-gravity halo we had to take two completely new hypotheses.

The density of rest energy ε_0 occurring on the right-hand sides of gravitational field equations is given by the expression [4]:

$$\varepsilon_0 = \frac{1}{2}\rho c^2 .$$

Gluing the solution inside the source mass with the solution outside the source mass is made possible by the two-potentiality of stationary gravitational field [5].

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