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SOME INTERESTING PROPERTIES OF WHILE HOLE IN THE VECTOR MODEL FOR GRAVITATIONAL FIELD

VO VAN ON
Department of Physics, Natural Science Faculty, Thu Dau Mot University

Abstract. *There is a strange macro object existing in the vector model for gravitational field, called while hole, it appears after the black hole disappear and has many strange properties. In this paper we show some its interesting properties and point out a object similar to it in universe.*

I. WHILE HOLES IN THE VECTOR MODEL FOR GRAVITATIONAL FIELD

In the vector model for gravitational field, we assume that gravitational field is a vector field, its source is the gravitational mass of matter. Along with the energy-momentum tensor of matter, this vector field contributes to warp the space-time by the following equation ([1]).

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R - g_{\mu\nu}\Lambda = -\frac{8G\pi}{c^4}T_{Mg.\mu\nu} + \omega T_{g.\mu\nu} \quad (1)$$

where $T_{Mg,\mu\nu}$ is the energy - momentum tensor of matter. $T_{g,\mu\nu}$ is the energy-momentum tensor of the gravitational field. From this equation, we have obtained a metric around a non rotating, non charged spherically symmetric object as follows ([2], [3]):

$$ds^2 = c^2(1 - 2\frac{GM_g}{c^2r} - \omega\frac{GM_g^2}{8\pi r^2})dt^2 - (1 - 2\frac{GM_g}{c^2r} - \omega\frac{GM_g^2}{8\pi r^2})^{-1}dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2) \quad (2)$$

We put $\frac{\omega}{8\pi} = \frac{G\omega'}{c^4}$ and rewrite the line element(2)

$$ds^2 = c^2(1 - 2\frac{GM_g}{c^2r} - \omega'\frac{G^2M_g^2}{c^4r^2})dt^2 - (1 - 2\frac{GM_g}{c^2r} - \omega'\frac{G^2M_g^2}{c^4r^2})^{-1}dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2) \quad (3)$$

Where

$$\begin{aligned} r_1 &= \frac{GM_g}{c^2}(1 - \sqrt{1+\omega'}) \approx -\omega'\frac{GM_g}{2c^2} \\ r_2 &= \frac{GM_g}{c^2}(1 + \sqrt{1+\omega'}) \approx \frac{2GM_g}{c^2} + \omega'\frac{GM_g}{2c^2} \end{aligned} \quad (4)$$

We calculate radii r_1,r_2 for a body whose mass equals to Solar mass and for a galaxy whose mass equals to the mass of our galaxy with $\omega' \approx -0.06$

- with $M_g = 2 \times 10^{30} kg$: $r_1 \approx 30m$, $r_2 \approx 3km$.
- with $M_g = 10^{11} \times 2 \times 10^{30} kg$: $r_1 \approx 3 \times 10^9 km$, $r_2 \approx 3 \times 10^{11} km$.

Thus, because of gravitational collapse, firstly at the radius r_2 a body becomes a black hole but then at the radius r_1 it becomes visible. Therefore, this model predicts the existence of a new universal body after a black hole.

II. PROPERTIES OF WHILE HOLES

II.1. Surface vibrations of while holes

In this section, we shall give a crucial approximation of the surface vibration of while hole. Let us consider an object with gravitational mass M_g which shrinks very close to the radius r_1(the object became a black hole!). At the boundary of r_1, under the influence of the force pulling into the center and the force pushing out from the center at the same time with approximate magnitude, the surface of body will vibrates. The equation of motion of mass m is: From the metric (3) we have

$$g_{\o\o} = (1 - 2\frac{GM_g}{c^2 r} - \omega' \frac{G^2 M_g^2}{c^4 r^2}) = (1 - 2\frac{\varphi_g}{c^2}) \tag{5}$$

With the effective potential

$$\varphi_g = (-\frac{GM_g}{r} + 0.03\frac{G^2 M_g^2}{c^2 r^2}) \tag{6}$$

Therefore

$$F_g = (-\frac{m_g GM_g}{c^2 r^2} + 0.03\frac{m_g G^2 M_g^2}{c^2 r^3}) \tag{7}$$

$$mr'' = m_g(-\frac{GM_g}{r^2} + 0.03\frac{G^2 M_g^2}{c^2 r^3}) \tag{8}$$

Due to

$$m_i = m_g \tag{9}$$

we have

$$r'' = (-\frac{GM_g}{r^2} + 0.03\frac{G^2 M_g^2}{c^2 r^3}) \tag{10}$$

The equation(10)determines the motion of a material element m at the surface of the object. Because of object just throbbing around the sphere surface with the radius r_1, we can set

$$r = r_1 + \delta r \tag{11}$$

Retaining only the first degree of small parameter, we have two the following equations:

$$r'' = -\frac{a}{r_1^2} + \frac{b}{r_1^3} \tag{12}$$

and

$$\delta r'' = -\omega^2 \delta r \tag{13}$$

With

$$a = GM_g; b = 0.03\frac{G^2 M_g^2}{c^2} \tag{14}$$

and

$$\omega^2 = r_1^{-3}(\frac{3b}{r_1} - 2a) \tag{15}$$

Because of two forces pulling and pushing are roughly equal at the surface r_1, r_1 changes very slowly, we will consider it later. From equation(13), we see that the surface of the sphere r_1 takes a harmonic oscillation with angle frequency almost constant by (15). Thus the sphere r_1 that we call the while hole will be throbbing like a variable star

II.2. The red shift and the blue shift of while holes

A special property of while holes in the model is the gravitational red shift due to gravity of while holes. The formula of the gravitational red shift Z in General Theory of Relativity is ([5]):

$$Z = \frac{\lambda_e - \lambda_o}{\lambda_e} = \frac{\sqrt{g_{00}(o)}}{\sqrt{g_{00}(e)}} - 1 = (1 - \frac{r_S}{r})^{-1/2} \tag{16}$$

where

$$r_S = \frac{2GM}{c^2} \tag{17}$$

is the Schwarzschild radius and

$$r = r_{rource} \tag{18}$$

is the radius of the source

$$r_{receiver} \to \infty \tag{19}$$

is the distance from source to observer. In this model, the formula of the gravitational red shift Z is:

$$Z = (1 - \frac{r_S}{r} + 0.015\frac{r_S^2}{r^2})^{-1/2} - 1 \tag{20}$$

From the formula(20), we have:

a/the domain I- normal object:

$$r : \infty \to r_2 \tag{21}$$

with red shift

$$Z : 0 \to +\infty \tag{22}$$

b/the domain II-black hole:

$$r : r_2 \to r_1 \tag{23}$$

c/the domain III- while hole

$$r : r_1 \to r_0 \tag{24}$$

with red shift

$$Z : +\infty \to 0 \tag{25}$$

d/ the domain IV - a while hole

$$r : r_0 \to 0 \tag{26}$$

with blue shift

$$Z : 0 \to -1 \tag{27}$$

III. RADIAL MOTION OF A PARTICLE INTO A WHILE-BLACK HOLE

We this section we shall consider radial motion of a particle into a while- black hole. We consider a particle falling radially into the central body with the particle having a velocity vector of$v^1 = dx/ds$. Since the particle falls in radially, we can take $v^2 = v^3 = 0$. The motion can be described by the geodesic equation

$$\frac{dv^\mu}{ds} + \Gamma^\mu_{\nu\sigma} v^\nu v^\sigma = 0 \tag{28}$$

which reduces to, for the case we are considering

$$\frac{dv^0}{ds} = -\Gamma^0_{\nu\sigma} v^\nu v^\sigma = -g^{00}\Gamma_{0,\nu\sigma} v^\nu v^\sigma = -2g^{00}\Gamma_{0,10} v^0 v^1 \tag{29}$$

From

$$\Gamma_{\mu,\nu\sigma} = (g_{\mu\nu,\sigma} + g_{\mu\sigma,\nu} - g_{\nu\sigma,\mu})/2 \tag{30}$$

we find

$$\Gamma_{0,10} = g_{00,1}/2 = \frac{\partial g_{00}}{2\partial x^1} \tag{31}$$

so (28) become

$$\frac{dv^0}{ds} = -g^{00}\partial g_{00,1} v^0 \frac{dx^1}{ds} = -g^{00}\frac{dg_{00}}{ds} v^0 \tag{32}$$

Due to $g^{00} = 1/g_{00}$, so we finally get

$$g_{00}\frac{dv^0}{ds} + \frac{dg_{00}}{ds} v^0 = \frac{d(g_{00}v^0)}{ds} = 0 \tag{33}$$

This integrates to

$$g_{00}v^0 = k \tag{34}$$

with k is an integration(the value of g_{00} where the particle starts to fall). From

$$ds^2 = g_{\mu\nu} dx^\mu dx^\nu \tag{35}$$

We have

$$1 = g_{\mu\nu} v^\mu v^\nu = g_{00}(v^0)^2 + g_{11}(v^1)^2 \tag{36}$$

Multiplying this equation by g_{00}, we obtain

$$g_{00} = (g_{00})^2 (v^0)^2 + g_{00} g_{11} (v^1)^2 \tag{37}$$

We have from(3) :

$$g_{00} g_{11} = -1 \tag{38}$$

Substituting this and (34) into (37), we get

$$k^2 - (v^1)^2 = g_{00} = 1 - r_S/r + 0.015(r_S)^2/r^2 \tag{39}$$

from which we obtain

$$(v^1)^2 = k^2 - 1 + r_S/r - 0.015(r_S)^2/r^2 \tag{40}$$

For a falling body $v^1 < 0$, hence

$$(v^1) = -\sqrt{(}k^2 - 1 + r_S/r - 0.015(r_S)^2/r^2)^{1/2} \tag{41}$$

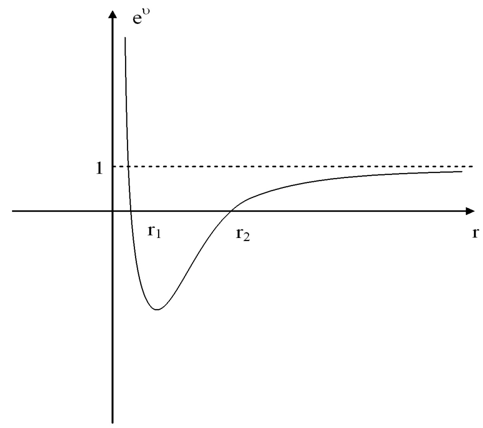

Fig. 1. The graph of e^ν: black hole starts from $r_2 \to r_1$, while hole starts from $r_1 \to 0$

Now, we consider dt/dr

$$\frac{dt}{dr} = \frac{dx^0/ds}{dx^1/ds} = \frac{v^0}{v^1} \tag{42}$$

and from(34) we have

$$v^0 = k/g_{00} = k/(1 - r_S/r + 0.015(r_S)^2/r^2) \tag{43}$$

so

$$dt/dr = v^0/v^1 = -k(1 - r_S/r + 0.015(r_S)^2/r^2)^{-1}(k^2 - 1 + r_S/r - 0.015(r_S)^2/r^2)^{-1/2} \tag{44}$$

Let us now suppose the particle is close to the critical radius r_2, so we set $r = \epsilon + r_2$,with ϵ small, and let us neglect ϵ^2. Then

$$dt = -1.0467 r_2 \frac{dr}{r - r_2} \tag{45}$$

This integrates to

$$t = -1.0467 r_2 \ln{(r - r_2)} + C \tag{46}$$

Thus, as $r \to r_2$ and $t \to \infty$, and the particle takes an infinite time to reach to the radius r_2. In this model the surface defined by $r = r_2$ is called the *event horizon* with $r_2 = 0.985 r_S$. When the particle falling into the while hole, the domain III and IV $r : r_1 \to 0$, we have also the result as follows

$$t = -0.0513 r_1 \ln{(r_1 - r)} + C \tag{47}$$

where $r_1 = 0.1532 r_S$ Thus, the particle take also a finite time to reach to the radius zero and an infinite time to reach to the radius r_1!

The graph of e^ν is showed in figure 1

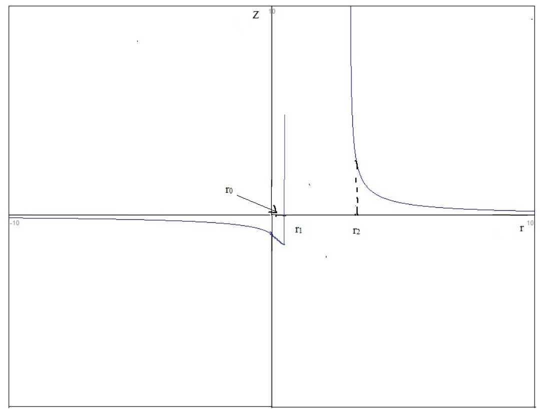

Fig. 2. The graph of z as a function of r . A while hole with $m = m_{Sun}$ has the radii as follows: $r_0 = 0.045km; r_1 = 0.04596km; r_2 = 2.9543km, r_S = 3km$

IV. DISCUSSION AND CONCLUSION

With the strange properties of the while holes as above discussion, what can the candidates of while holes be ? In our opinion, the candidates of while holes can just be quasars! Quasars have the properties as follows([5])

- Quasars have the high red shift,

- Quasars have the sizes are small by observed data,

- Quasars have the variation of the brightness in the optical domain and the x-ray domain.

- Quasars have only the red shift but have no the blue shift. A more detailed research of the problem shall do in the future.

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