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ON THE ORBITAL MOTION OF A BODY IN A SPHERICALLY SYMMETRIC FIELD IN ROSEN'S BIMETRIC GRAVITATION THEORY

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In this work we expose an illustrative example to some theoretical results obtained in previous papers (Lukačević, 1994; 1995). We give, for simplicity, a qualitative approach only, but with a good possibility for further quantitative study. Previous papers lacked concrete expression for the conformal factor. That factor is determined by a solution of the wave equation in the background metric. The basic static spherically symmetric metric (Rosen,) is conformally transformed by means of it. The quantitative study, better to say the geometrical plotting of particular solutions, as in Ćatović (1992), will be the object of further work. We point out the fact that the conformal factor chosen is a function of the coordinate time and of the radial variable. It corresponds to outgoing waves and it satisfies two differential inequalities, with the consequence that the orbital motion considered is accelerated. Such a motion is the only to be physically justified.

The metric element in a nonstatic spherically symmetric field in the bimetric gravitation theory reads

$$\epsilon d\tilde{s}^2 = e^{2\varphi(r,t)}\left[e^{2M/r}(dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\lambda^2) - e^{-2M/r}c^2dt^2\right] \qquad (1)$$

The radial coordinate r, slightly differs (in astronomical problems) from radial distance (Rosen,). It has been choseen in order to put the metric element in the homogeneous form (1). φ is the solution of the wave equation in Minkowskian metric (Lukačević and Ćatović, 1992)

$$\Box\varphi = 0 \qquad (2)$$

The accelerated orbital motion of a celestial body in the metric (1) is the consequence of the fact that φ satisfies two differential inequalities

$$\frac{\partial\varphi}{\partial r} > 0, \frac{\partial\varphi}{\partial t} < 0 \qquad (3)$$

We further assume $\varphi < 0$ in order to have monotonously increasing and vanishing at the space-like infinity.

Having all that in mind, we chose a d'Alambertian solution (2), corresponding to outgoing waves only, of the form

$$\varphi = \frac{L}{r} \ln \operatorname{th}\left[(ct-r)^{-k}\right] \tag{4}$$

We assume $0 < k << 1$ and $L \sim M$, M being the "gravitational radius" from (1). The function φ satisfies (2) and (3) for physically realistic values of the arguments. So, we have

$$\epsilon d\tilde{s}^2 = \sinh^{2L/r}\left[(ct-r)^{-k}\right]\left[e^{2M/r}(dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\lambda^2) - e^{-2M/r}c^2 dt^2\right] \tag{5}$$

for (1). The conformal factor multiplying the static part of the metric in (5) is so chosen as to be a monotonous and slowly increasing function of r, and slowly decreasing of t. Finally, in the interval considered, that function is nearly equal to unity.

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