LETTERS TO PROGRESS IN PHYSICS

On Crothers' Assessment of the Kruskal-Szekeres "Extension"

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I agree with Crothers in it that any introduction of Kruskal-Szekeres coordinates is unnecessary. The solution of problems from so-called Schwarzschild solutions appears amazingly simpler than discussed in Crothers' paper.

S. J. Crothers [1] discusses the introduction of Kruskal-Szekeres coordinates, which pursue the target to avoid certain forms of singularity and the change of signature. Crothers argues that this measure is off target. — Let me note following:

1. The Kruskal-Szekeres coordinates as quoted with the equations before Eq. (4) of [1] mingle time and length. That is physically self-defeating. Moreover, any real coordinate transformation does not change the situation with the original coordinates.

2. The solution according to Eq. (1) of [1] is physically difficult for the coordinate singularity. We should take notice of this fact instead of doing inept tries, see item 1.

3. The general central symmetric and time-independent solution of $R_{\mu\nu} = 0$ is the first part of Schwarzschild's actual solution

$$ds^2 = \left(1 - \frac{\alpha}{R}\right)dt^2 - \left(1 - \frac{\alpha}{R}\right)^{-1} dR^2 - \\ - R^2(d\theta^2 + \sin^2\theta\, d\varphi^2)\,,$$

in which R is an *arbitrary* function of r within the limit that metrics must be asymptotically Minkowski spacetime, i.e. $R \Rightarrow r$ for great r. α is an integration constant related to the mass,

$$\alpha = \frac{\kappa m}{4\pi}\,.$$

This solution is based on "virtual" coordinate transformation, which is possible for the degrees of freedom from Bianchi identities.

4. Above solution implies also an isotropic solution without singularity at the event horizon

$$ds^2 = \left(\frac{r - r_g}{r + r_g}\right)^2 dt^2 - \\ -\left(1 + \frac{r_g}{r}\right)^4 \left(dr^2 + r^2(d\theta^2 + \sin^2\theta\, d\varphi^2)\right)$$

with

$$r_g = \frac{\alpha}{4} = \frac{\kappa m}{16\pi}\,.$$

The event horizon (at $r = r_g$) turns up to be a geometric boundary with $g = 0$.

5. Any change of signature is physically irrelevant, because areas with different signature (from normal, according to observer's coordinates) are not locally imaged. Therefore, any singularity in such an area is absolutely irrelevant.

6. It is deduced from the geometric theory of fields [2] that particles do not follow any analytic solution, no matter whether obtained from General Relativity or any quantum theory. One can specify the field only numerically. It has to do with chaos. — It was interesting to see if the discussed analytic solutions are possible at all, or if macroscopic solutions are decided by chaos too.

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References

1. Crothers S. J. The Kruskal-Szekeres "extension": counter-examples. *Progress in Physics*, 2010, v. 1, 3–7.
2. Bruchholz U. E. Key notes on a geometric theory of fields. *Progress in Physics*, 2009, v. 2, 107–113.