Theoretical Physics

Reissner–Nordström anti-de Sitter black holes and energy

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Abstract. We show that the tetrad field whose metric gives the Reissner–Nordström anti-de Sitter black holes gives the correct value of energy in Møller tetrad theory of gravitation.

Mustafa et al. have derived a Reissner–Nordström anti-de Sitter black hole solution in Møller tetrad theory of gravitation [1]. Next, calculations of the energy of these black holes in the spherical polar coordinate have been carried out. The result of these calculations gives the energy in the form

$$E = M - \frac{Q^2}{r} + \frac{r^3}{l^2} \,. \qquad (1)$$

They discussed these results according to the results of the calculated energy given in the framework of general relativity. We have some comments on this discussion.

First of all the calculations of the energy that have been done in the spherical polar coordinate is not right because P^μ used in these calculations does not transform as a 4-vector under a linear coordinate transformation [2]. The calculations will be more accurate in Cartesian coordinates [3–5], and we have done such calculations and obtained the necessary components of the superpotential of (22) in [1]:

$$\mathcal{U}_0^{0\alpha} \simeq \frac{2n^\alpha}{\kappa r^3} \left[M - \frac{Q^2}{2r} + \frac{r^3}{2l^2} \right] \,. \qquad (2)$$

Using (2) in (10) of [1] we obtain the energy in the form

$$E = M - \frac{q^2}{2r} + \frac{r^3}{2l^2} \,, \qquad (3)$$

which is the correct result of energy associated with Reissner–Nordström anti-de Sitter black holes.

References

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