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A new Energy-Momentum Pseudotensor in General Relativity

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Abstract. We show the existence of a pseudotensor $t_\gamma{}^i$ with the property $\left[g\left(t_\gamma{}^i + T_\gamma{}^i\right)\right]_{,i} = 0$ for the Einstein theory of the gravitation.

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04.90.+e Other topics in general relativity and gravitation.

Pseudotensors are not covariant objects because they inherently depend on the reference frame, and by their very nature cannot provide a genuine physical local gravitational energy-momentum density [1-7]. Examples of pseudotensors $t^{\gamma i}$ in general relativity satisfying the following conservation law:

$$\left[(-g)^{n/2}\left(t^{\gamma i} + T^{\gamma i}\right)\right]_{,i} = 0 \quad \textbf{(1)}$$

for *n=1* and *n=2* are the complexes of Stachel [8] and Landau-Lifshitz [3,9-11], respectively. On the other hand, Einstein [4,10,12] and Möller [13-16] published pseudotensors verifying the continuity equation:

$$\left[(-g)^{n/2}\left(t_\gamma{}^i + T_\gamma{}^i\right)\right]_{,i} = 0 \quad \textbf{(2)}$$

for *n=1*. Our contribution is to exhibit a complex with the property (2) when *n=2*; in fact, its expression is given by:

$$t_\gamma{}^i = \underset{M}{t_\gamma{}^i} + \frac{1}{8\pi\sqrt{-g}}\left[\left(\sqrt{-g}_{,jh} - \sqrt{-g}_{,c}\Gamma^{c}{}_{jh}\right)g_{k\gamma} + \sqrt{-g}_{,h}\Gamma_{k\gamma j} + \sqrt{-g}_{,j}\Gamma_{k\gamma h}\right]\left(g^{ih}g^{jk} - g^{ik}g^{jh}\right)$$
(3)

being $\underset{M}{t_\gamma{}^i}$ the Möller's pseudotensor. In other paper we will elaborate applications of (3) for metrics of interest in general relativity.

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