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ANTI-GRAVITY EFFECTS IN THE SACHS THEORY OF ELECTRODYNAMICS

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It is demonstrated to a first approximation that anti-gravity effects can occur in the most general theory of electromagnetism, developed by Sachs [1] from the irreducible representations of the Einstein group.

Key words: anti-gravity, Sachs's electrodynamics, Einstein group.

1. INTRODUCTION

Sachs has demonstrated [1] that the most general form of electrodynamics is obtained from a consideration of the irreducible representations of the Einstein group and that the electromagnetic field tensor is proportional to the curvature tensor. Therefore, in the flat spacetime vacuum where there is no charge or mass the electromagnetic field cannot propagate, directly contradicting the notion in Maxwell-Heaviside theory [2,3] that the electromagnetic field can propagate in a source-free region in special relativity. The fundamental reason for this contradiction is that special relativity is an asymptotic limit of general relativity, but one which is never reached: If there is charge or mass anywhere in the universe then all spacetime is curved [1], leading directly to the conclusion that the electromagnetic field tensor is proportional to the curvature tensor, and so can only propagate in the presence of a source. This conclusion is also reached in O(3) electrodynamics [4-10], removing the anomaly in U(1) electrodynamics that an electromagnetic field can propagate in a source-free region, implying that there is effect without cause. In this paper it is shown in a first approximation that the Sachs theory can lead in principle to anti-gravity effects. In Sec. 2 it is shown that the electromagnetic field tensor influences the gravito-electromagnetic canonical energy-momentum T_μ [1], which is quaternion-valued. In general therefore, the electromagnetic field may influence the gravitational field and vice-versa, because the theory by Sachs [1] unifies both fields.

2. INFLUENCE ON THE ELECTROMAGNETIC FIELD TENSOR

Following the development by Sachs [1], the unification of the electromagnetic and gravitational fields is obtained by factorizing the Einstein field equation into

$$\frac{1}{4}\left(K_{\rho\lambda}q^\lambda + q^\lambda K^+_{\rho\lambda}\right) + \frac{1}{8}Rq_\rho = kT_\rho, \tag{1}$$

where $K_{\rho\lambda}$ is the curvature tensor and q^λ is the quaternion-valued metric with sixteen components

$$q_\rho = \left(q^0_\rho, q^1_\rho, q^2_\rho, q^3_\rho\right); \tag{2}$$

herein R is the scalar curvature, k the Einstein constant, and T_ρ the quaternion-valued gravito-electromagnetic canonical energy-momentum

$$T_\rho = \left(T_\rho^0, T_\rho^1, T_\rho^2, T_\rho^3\right). \tag{3}$$

This has sixteen components in general, but if there is no linear momentum and a static electromagnetic field configuration (no Poynting vector), then

$$T_\rho = \left(T_\rho^0, 0, 0, 0\right), \tag{4}$$

and the problem reduces to four equations in four unknowns. The T_0^0 component is that of the canonical energy due to the gravito-electromagnetic field represented by q_0^0. The scalar curvature R is the same with and without electromagnetism, and so is the Einstein constant k.

Equation (1) is a gravito-electromagnetic equation. If consideration is restricted to T_0^0, then $\rho = 0$ and therefore

$$kT_0 := \frac{1}{8} R q_0^0 + \frac{1}{4}\left(K_{0\lambda} q^\lambda + q^\lambda K_{0\lambda}^+\right). \tag{5}$$

If we chose a metric such that all components go to zero except q_0^0, then R must vanish for $T_0 := 0$. This implies vanishing mass. Alternatively, in order to produce anti-gravity effects, the electromagnetic field must be chosen so that curvature is minimized without R actually vanishing. The latter would imply the physically unreal case of flat spacetime, where the field could not propagate. One possibility is

$$q_0^0 \gg (q_1^0 \sim q_2^0 \sim q_3^0), \tag{6}$$

a result which implies self-consistently that the curvature tensor must be minimized. The curvature tensor is defined as

$$K_{\rho\lambda} := -K_{\lambda\rho} = \Omega_{\rho;\lambda} - \Omega_{\lambda;\rho}. \tag{7}$$

If $\rho = 0$, then $\Omega_{0;\lambda} \sim \Omega_{\lambda;0}$, and so the curvature tensor can be minimized if the spin affine connection is minimized. We must therefore investigate the effect of minimizing $K_{0\lambda}$ on the electromagnetic field tensor [1]:

$$\begin{aligned} F_{\rho\lambda} &= Q\left[\frac{1}{4}\Big(K_{\rho\lambda} q^\lambda q_\gamma^* + q_\gamma q^{\lambda *} K_{\rho\lambda}\right. \\ &\left. \quad + q^\lambda K_{\rho\lambda}^+ q_\gamma^* q_\gamma K_{\rho\lambda}^+ q^{\lambda *}\Big) + \frac{1}{8}\left(q_\rho q_\gamma^* - q_\gamma q_\rho^*\right) R\right]. \end{aligned} \tag{8}$$

We know that $R \to 0$, and $\rho = 0$, so:

$$F_{0\gamma} = Q\left[\frac{1}{4}\left(K_{0\lambda}q^{\lambda}q^{*}_{\gamma} + \ldots\right)\right], \tag{9}$$

and therefore the $F_{0\gamma}$ component must be minimized. This represents the electric component. Therefore the magnetic field component must be very large compared with the electric field component if we are considering a static configuration.

3. DISCUSSION

As soon as the T^0_0 component begins to be minimized, the momentum parts of T_μ become non-zero, so the problem becomes one which can only be addressed with numerical techniques. For example, if $F_{\rho\gamma}$ is known for a particular experiment, then the metrics, curvature tensor, and scalar curvature in Eq. (8) can be found by a multi-parameter fitting program and used in Eq. (1) to determine the effect on T_μ, which in general has sixteen components. The effect of a given electromagnetic field on mass must be found by considering the sixteen components of T_μ. In principle, anti-gravity effects are possible from the Sachs theory, which considers irreducible representations of the Einstein group [1]. To determine these precisely is, however, a non-trivial numerical problem.

The quaternion-valued T_μ represents canonical energy-momentum from curved spacetime; thus, if curved spacetime can be considered as the vacuum, electromagnetic energy can be obtained from the vacuum in the form of a vacuum four-current [1], part of whose structure involves -1_μ. Recently, Godin [11] has reported a reduction in mass due to an electromagnetic field, and the effect is possible in principle in Sach's theory [1].

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