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ON CHARGE CONSERVATION IN A GRAVITATIONAL FIELD

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Abstract. According to the "gravitationally-modified" Maxwell equations that were proposed for an alternative scalar theory with an "ether", electric charge would not be conserved in a time-dependent gravitational field. We define an asymptotic expansion scheme for the electromagnetic field in a weak gravitational field. This allows us to assess the amounts of charge production or destruction which are thus predicted. These amounts seem high enough to discard that version of the gravitationally-modified Maxwell equations. We show that this failure is due to the former assumption of additivity of the energy tensors: an "interaction energy tensor" has to be added. Then the standard Maxwell equations in a curved spacetime become compatible with that scalar theory, and they predict charge conservation.

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1. Introduction

An alternative theory of gravitation based on a scalar field alone, and having a preferred reference frame, has been proposed previously [1, 2, 7]. Recently, equations for the electromagnetic field in the presence of a gravitational field have been derived for this theory [9] and it has been found that they lead to a violation of the conservation of electric charge. The aim of this contribution is to give a short account of the work that has been done to assess the magnitude of this effect, and to outline the consequences that followed for the theory from this assessment. (A detailed account has been given elsewhere [10].) Let us first summarize the three main motivations for this "scalar ether theory" of gravitation, in short SET.

1) The first motivation is to extend to the situation with gravitation the *Lorentz-Poincaré version of special relativity*. The latter version is more often called