A MODEL OF CHARGE

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In this work a new, fundamentally non-linear term supplements Maxwell's and Einstein's Lagrangians. This term contains the acceleration of the charge. The field equations obtained from the variation principles are examined qualitatively only. The model gives a classical explanation of spin.

1. Introduction

The classical electron models (Thomson, Lorentz, Abraham, Poincaré, ..., Dirac), the Quantum Mechanics and the Quantum Field Theory have not, as yet, solved the problems of the inner structures of the elementary particles. In view of this, it was thought reasonable to look for new ways in this field.

The new approach followed here is somewhat unusual: In the scope of General Relativity the acceleration of the charge is taken into the Lagrangian. The most important purpose is to explain the spin of a charged particle with the help of some non-linearities in the Lagrangians. The field equations obtained with the simple tools of Classical Field Theory will be highly complex and hardly interpretable, but perhaps some quantum properties of the charge can be explained classically, too. It is important to mention that this model also contains Maxwell's Electromagnetic Field.

The Lagrangian Functions will be detailed first, then the field equations will be listed; following these the interactions written by the vector potential will be examined and the problem of the gauge-invariancy will be touched on; finally some macroscopic quantities of the charge will be calculated.

2. The action principle

The starting point is the action:

\[ S = \int \int (L_g + L_e + L_{eq} + L_q) \sqrt{-g} \, d\Omega. \]  

(1)

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Here $L_g$ is the Lagrangian of Einstein’s Gravitational Field. In this work the basic vectors build up the metric tensor:

$$g_{\alpha \beta} = g_{\Lambda \Delta} e^\alpha_a e^\beta_b.$$  \hspace{1cm} (2)

Here $g_{\Lambda \Delta}$ is the constant Minkowski’s Tensor, $e^\alpha_a$ are the basic vectors. Thus, the following expression is obtained for $L_g$

$$L_g = \frac{c^4}{16\pi G} g_{\Lambda \Delta} (e^\Lambda_a \eta e^{\Delta \rho} - e^\Lambda_\rho \eta e^{\Delta a}).$$  \hspace{1cm} (3)

This expression is invariant scalar and does not contain the second order derivatives.

The use of the basic vectors is advantageous when the macroscopic momentum is calculated, and when there are some spinors in the curved space-time. In the latter case the energy-momentum tensor cannot be calculated without the basic vectors. $L_e$ is the well-known Maxwell’s Electromagnetic Lagrangian:

$$L_e = -\frac{1}{4\mu_0} F_{\alpha \beta} F^{\alpha \beta}.$$  \hspace{1cm} (4)

Here

$$F_{\alpha \beta} = \mu_0 (A_{\beta;\alpha} - A_{\alpha;\beta})$$  \hspace{1cm} (5)

and $A_\alpha$ is the vector potential.

$L_{eq}$ is the interacting Lagrangian between the current density and the potential field. In this work it is taken in the following form:

$$L_{eq} = \alpha (-I_\theta I^\delta) I^\rho A_\rho.$$  \hspace{1cm} (6)

Here $\alpha$ is a constant, and $d$ is a power index. $I^\alpha$ is a vector field, which generally is not equal to the current density except for $d = 0$. The power factor makes it possible to describe, for instance, the case of the identically constant proper charge density.

The Lagrangian of the charge has the form:

$$L_q = -\beta (-I_\delta I^\theta)^b d^\rho.$$  \hspace{1cm} (7)

Here $\beta$ is a constant, $b$ and $f$ are power indices, and

$$a = \sqrt{a_\rho a^\rho},$$  \hspace{1cm} (8)

$$a_\rho = u^\rho, d^\delta,$$  \hspace{1cm} (9)

$$u^\rho = I^\rho/\sqrt{-I_\delta I^\delta}.$$  \hspace{1cm} (10)