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Gravitation and Electromagnetism

Abstract. The set of the symmetrical Maxwell equations and the fundamental Newton law of motion are formally postulated as a basis of a unified field theory which can logically and consistently summarise and classify the classical Newton gravitational and the Maxwell electromagnetic field theory with all experimental laws and facts from those two theories.

1. Introduction. The existence of the gravitational and electromagnetic fields has been known for a long time, but apparently, no relation between those two fields has been found so far experimentally. This fact is probably one of the reasons of our rather poor understanding of the phenomenon of gravitation.

An attempt will be made in this paper to set up a unified field theory in a formal, axiomatic way, dealing only with gravitational and electromagnetic fields. No attempt will be made to discuss the other unified field theories proposed so far, since this unified field theory is quite different and independent from them.

2. Symmetrical Maxwell Equations. Let us consider the symmetrical Maxwell equations

$$\nabla\cdot\vec{g} = 4\pi k\rho \quad , \qquad \nabla\cdot\vec{h} = n\rho_e \quad , \tag{1}$$
$$\nabla\times\vec{g} = -n\rho_e\vec{v} - \frac{\partial\vec{h}}{\partial t} \quad , \qquad \nabla\times\vec{h} = \frac{4\pi k}{c^2}\rho\vec{v} + \frac{1}{c^2}\frac{\partial\vec{g}}{\partial t} \quad ,$$

together with the volume force

$$\vec{f} = -\rho\vec{g} - \rho\vec{v}\times\vec{h} - n_1\rho_e\vec{h} + n_2\rho_e\vec{v}\times\vec{g} \ . \tag{2}$$

$\vec{g}$ is identified with the gravitational field, and ρ with the mass density. k is the gravitational constant, c is the speed of light in vacuum, and $\vec{v}$

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is the mass velocity. $\vec{h}$ is an auxiliary hypothetical field, so that the interplay of $\vec{g}$ and $\vec{h}$ defines the finite velocity of propagation of the gravitational effects equal to c . ρ_e is identified as the electrical charge density, while $\rho_e \vec{v}$ is the electrical current density. n , n_1 and n_2 are suitable constants to be discussed later.

The symmetrization of the ordinary Maxwell equations is justified by the powerful principle of symmetry. Further, from such a set of the symmetrical Maxwell equations we can purely formally obtain a linear gravitational field theory, as well as the electromagnetic field theory in a straightforward logical way, consistent with numerous experimental laws and facts.

3. The gh Field. Let $\rho_e = 0$, i.e. let consider the case of neutral masses from the macroscopic point of view. Then (1) reduces to the set of the ordinary Maxwell equations of the gh field, i.e. a linear gravitational field theory is obtained, which was suggested in [1] and [2] . The Newton law of motion must be naturally added in connection with (2), since the field equations do not contain the equation of motion, provided the principle of equivalence of gravitational and inertial mass is assumed to be valid unrestrictedly. For $|\vec{v}|$ small compared with c , this linear gravitational field theory reduces immediately to the classical Newton gravitational theory. On the other hand, since the equations of the general relativity theory bear resemblence to the ordinary Maxwell equations, and the special relativity theory is actually based on them, numerous results from both those theories, but by no means all, can be immediately brought into this linear gh field theory.

4. The Electromagnetic Field. Let $\rho = 0$, i.e. let consider the case of electrical charges and currents whose masses are negligibly small from the macroscopic point of view. In this case, since ρ_e is the electrical charge density, and $\rho_e \vec{v}$ is identified as the electrical current density, the set (1)

must be equivalent to the ordinary Maxwell equations of the electromagnetic field. Therefore, we postulate

$$\vec{E} = n_1 \vec{h} \quad , \quad \vec{B} = n_2 \vec{g} \quad , \tag{3}$$

as well as

$$n n_1 = \frac{1}{\varepsilon_0} \quad , \quad n n_2 = \mu_0 \quad , \quad \frac{n_1}{n_2} = \frac{1}{\varepsilon_0 \mu_0} = c^2 \ . \tag{4}$$

Thus, the $\vec{h}$ field is formally identified with the electric field $\vec{E}$, and the $\vec{g}$ field is formally identified with the magnetic field $\vec{B}$, with, of course, suitable constants of proportionality. ε_0 and μ_0 are the basic electromagnetic constants for the free space in the MKS system of units.

With (3) and (4) the set (1) in this case formally reduces to the ordinary Maxwell equations of the electromagnetic field with some different signs, which can be changed appropriately to suit the physical facts. Namely, the Maxwell electromagnetic field theory is contained in (1) and (2), as well as a linear gravitational field theory, provided (3) and (4) are postulated.

5. Discussion. The relations (3) were postulated formally in order to obtain the BE field from (1). Let us now assume that those relations are physically valid. The immediate problem before us is the meaning and the numerical values of the introduced constants n, n_1 and n_2, as well as the consistency with the experimental facts. That consistency can be preserved, if we assume that n_2 is of the order 10^a weber·sec^2/m^3, with a positive, and n_1 of the order 10^{17+a} weber/m. In such a case, the static earth gravitational field appears to be an extremely strong static magnetic field of the order 10^3 weber/m^2 (if $a = 2$) superimposed with the time varying component, i.e. the conventional earth magnetic field, which is presumably influenced by masses of sun, moon and other planets, and due also to some causes inside the earth itself. This is consistent with the observable facts. However, it must be emphasized that n_2 must have its upper limit, with a probably not exceeding 2 or 3, since otherwise, mountainous masses, nonmagnetic

in the conventional sense of the word, could produce a rather strong magnetic, i.e. gravitational field whose horizontal component could be larger than the horizontal component of the conventional earth magnetic field, which would contradict the observed facts. But with n_2 limited, the horizontal component of the field of any mountainous mass is presumably masked within the horizontal component of the conventional earth magnetic field. On the other hand, a moderately strong electric field appears to be a vanishingly weak $\vec{h}$ field. With the above suggested values for n_1 and n_2, no contradiction has been found by this author with the experimental facts in the macroscopic domain. Consequently, neutral masses are rather weak sources of magnetic, i.e. gravitational field compared with electrical currents, while electrical charges are much stronger sources of electric field compared with mass currents. The screening of the earth gravitational, i.e. extremely strong static magnetic field appears to be practically impossible, unless enormous masses or enormous electrical currents are employed, very far beyond our present technological ability.

The actual values of n_1 and n_2 should be, of course, obtained experimentally. However, since the new effects predicted by this theory, like the deflection of neutral masses in an electric field, etc., are very probably vanishingly weak, it may prove rather difficult to perform those measurements.

It is interesting to notice that the equations (1) admit a possibility to define electrical charge as fast rotating pure mass, and vice versa, with the direction of rotation defining the sign. This is in accordance with the existence of both positive and negative charges. However, negative mass has not been observed so far, but the equations (1) and (2) are completely consistent with the assumption that negative mass exists.

In the microscopic domain, the earth gravitational field, i.e. the static, ever-present extremely strong magnetic field would force a single charged particle to gyrate with an extremely small radius of gyration and no possibility for the inertial motion. In order to reconcile that with the experimental fact that

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a charged particle can move inertially through the earth gravitational field, a single, stable charged particle is to be defined in such a way that its self intrinsic fields, due to its fast rotation and its rather very large microscopic mass density, balance appropriately all static fields present at the moment when a stable charged particle is created, if it is to be a stable one. Any additional field, which is of necessity a transient one as far as a stable particle is concerned, exerts the appropriate componental force given by (2). A model, presumably sherelike or toroidal, of fast rotating pure mass with the nonuniform mass density, which is very large compared with mass densities in macrocosm, must be postulated for a stable charged particle in this unified field theory. Such a model can be formed following similar arguments as suggested in [3]. It should be, however, mentioned that magnetic moment of a particle is closely associated with its mass from the point of view of this unified field theory.

It is evident that the microscopic domain presents a real challenge for this proposed unified field theory, but further theoretical and experimental research in that direction is essential, if this theory is to applied to that domain.

6. Conclusion. The set (1) together with (2), (3) and (4) can be formally postulated to form a basis of a unified field theory which can be made consistent with numerous experimental laws and facts involving gravitational and electromagnetic phenomena, but very many serious problems, particularly in the microscopic domain, still remain unsolved. This theory, like every theory in physics, naturally has its limitations. Nonlinear phenomena cannot be explained within the framework of a linear theory like this, unless further hypotheses are introduced. Quantization, for instance, must be certainly introduced into this theory, if it is to be applied in the microscopic domain.

It should be mentioned that the mass variation with velocity can be interpreted in this unified field theory as the nullification of the net force when $v = c$, since the field effects propagate with the same speed c, i.e. there is no need

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to resort to the concept of infinite mass when $v = c$. From the experimental point of view it is impossible to distinguish whether mass becomes infinite, or net force equal to zero when $v = c$, since acceleration in both cases is zero. On the other hand, the set of equations (1) is formally Lorentz covariant with all physical implications of that fact, if ρ in those equations is treated as the rest mass density.

Since the gh field is identical with the BE field from the point of view of this unified field theory, the gravitational waves appear to be presumably nothing else but the well-known electromagnetic waves, i.e. light. This conclusion is consistent with the fact that the gravitational waves have not been observed so far [4].

Furthermore, the duality of light is not a necessary postulate in order to explain the photoeffect within the framework of this unified field theory. Namely, pure mass in a periodic gh, i.e. BE field, i.e. monochromatic light superimposed on static $\vec{B}$ and $\vec{E}$ fields, is forced to rotate with the synchronous angular velocity equal to the frequency of light, and it naturally granulates, i.e. is quantized, until stability and balance between the self and the external fields are achieved. This problem is analytically identical to a corresponding problem in plasma physics. In this connection, it can be seen from the set (1) that charge, defined in such a way, is proportional to the angular velocity. In view of that, it is possible to obtain the well-known energy expression for a photoelectron $h(\nu-\nu_0)$ without resorting to the duality of light. However, the Compton effect is much more complex and is not so readily explainable.

It is impossible to discuss in a single paper all the numerous problems and questions raised by this unified field theory, which was postulated here in a formal, almost axiomatic way. It combines two fields in one. It predicts some new effects, like the deflection of neutral masses in an electric field, etc., but those effects are probably very weak to be easily detectable. However, experimental research must ultimately provide results as to its physical validity

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and limitations. Without further experimental proofs forthcoming, this unified field theory should be considered only as a mathematical possibility of logically and consistently summarizing and classifying the two unrelated classical field theories, postulating only a simple set of the symmetrical Maxwell equations and the fundamental law of motion, as well as the conservation laws.

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Short biographical sketch

Born in Shabats, Serbia, Yugoslavia in 1925. Obtained the Electrical Engineer degree from the Belgrade University, College of Electrical Engineering in Belgrade, Yugoslavia in 1951, the Sc.D. degree from the Serbian Academy of Sciences in Belgrade, Yugoslavia in 1954. Since the graduation in 1951, employed by various research institutes in Belgrade. Published a number of papers in Serbian and English. Visiting Assistant Professor of Electrical Engineering at the Northeastern University in Boston, Massachusett during the 1959-1960 academic year. Since 1961 Associate Professor of Electrical Engineering at the University of New Mexico in Albuquerque, New Mexico.