ISSN 2347-3487

A Note on non-relativistic gravitation

Pierre Hillion
Institut Henri Poincaré, 86 Bis Route de Croissy, 78110 Le Vésinet, France
e-mail : pierre.hillion@wanadoo.fr

Abstract

Using the Jefimenko theory of gravitation [1] and the Le-Bellac, Levy-Leblond non relati-vistic approximations of Maxwell equations, we prove that in addition to newtonian gravi-tation, there exists a second non-relativistic gravitation.

Council for Innovative Research
Peer Review Research Publishing System
Journal: JOURNAL OF ADVANCES IN PHYSICS
Vol. 11, No. 3
www.cirjap.com, japeditor@gmail.com

INTRODUCTION

Using the Jefimenko theory of gravitation [1] and the Le-Bellac, Levy-Leblond non relati-vistic approximations of Maxwell equations, we prove that in addition to newtonian gravi-tation, there exists a second non-relativistic gravitation.

1. JEFIMENKO THEORY

The Jefimenko theory [1] of gravitation is obtained from electromagnetism by simply repla-cing the electromagnetic symbols and constants by the corresponding symbols and constants of gravitation in accordance with the following tables :

Table (1a) Electromagnetism	**Table (1b)** Gravitation
q (charge)	m (mass)
ρ (volume charge density)	ρ (volume mass density)
J (convection current)	**J** (mass current)
E (electric field)	**g** (gravitational field)
B (magnetic field)	**K** (cogravitational field)
ε_0 (permittivity)	$-1/4\pi G$
μ_0 (permeability)	$-4\pi G/c^2$
$\varepsilon_0\mu_0 = c^{-2}$	G (gravitational constant)

Then, using these tables, the Maxwell and gravitational equations are in vacuum :

Maxwell (2a)	Gravitation (2b)
$\nabla.\mathbf{E} = \rho/\varepsilon_0$	$\nabla.\mathbf{g} = -4\pi G\rho$
$\nabla.\mathbf{B} = 0$	$\nabla.\mathbf{K} = 0$
$\nabla\wedge\mathbf{E} = -\partial_t\mathbf{B}$	$\nabla\wedge\mathbf{g} = -\partial_t\mathbf{K}$
$\nabla\wedge\mathbf{B} = \mu_0\mathbf{J} + 1/c^2\partial_t\mathbf{E}$	$\nabla\wedge\mathbf{K} = -4\pi G\mathbf{J}/c^2 + 1/c^2\partial_t\mathbf{g}$

The cogravitational field **K** is a special feature of the Jefimenko theorY.

2 NON RELATIVISTIC GRAVITATION

Now, it is known [2,3,4] that the Maxwell equations have two nonrelativistic limits respecti-

vely called electric (3a) and magnetic limits(4a) supplying according to the tables (1a,b) the non relativistic limits of the gravitational equations that we call gravilimit (3b) and cogra-vilimit (4b) corresponding respectively to (3a) and (4a) :

2

Electric limit (3a) [3]	Gravilimit (3b)
$\nabla.\mathbf{E}_e = \rho_e/\varepsilon_0$	$\nabla.\mathbf{g}_g = -4\pi G\rho_g$
$\nabla.\mathbf{B}_e = 0$	$\nabla.\mathbf{K}_g = 0$
$\nabla\wedge\mathbf{E}_e = 0$	$\nabla\wedge\mathbf{g}_g = 0$
$\nabla\wedge\mathbf{B}_e = -1/c^2\partial_t\mathbf{E}_e$	$\nabla\wedge\mathbf{K}_g = 1/c^2\partial_t\mathbf{g}_g$
Magnetic limit (4a) [3]	**Cogravilimit (4b)**
$\nabla.\mathbf{E}_m = \rho_m/\varepsilon_0$	$\nabla.\mathbf{g}_{cg} = -4\pi G\rho_{cg}$
$\nabla.\mathbf{B}_m = 0$	$\nabla.\mathbf{K}_{cg} = 0$
$\nabla\wedge\mathbf{E}_m = -\partial_t\mathbf{B}_m$	$\nabla\wedge\mathbf{g}_{cg} = -\partial_t\mathbf{K}_{cg}$
$\nabla\wedge\mathbf{B}_m = \mu_0\mathbf{J}_m$	$\nabla\wedge\mathbf{K}_{cg} = -4\pi G\mathbf{J}_{cg}/c^2$

3.GRAVITATION AND POTENTIALS

THe electromagnetic potentials V, **A** relating to fields in vacuum have the magnetic limit [3]

satisfying the coulomb gauge with a scalar potential V_m independent on time $\partial_t V_m = 0$

$$\mathbf{E}_m = -\nabla V_m - \partial_t\mathbf{A}_m \quad , \quad \mathbf{B}_m = \nabla\wedge\mathbf{A}_m \quad , \quad \nabla.\mathbf{A}_m = 0 \qquad (5a)$$

Similarly in the electric limit, the potentials satisfy the Lorentz gauge and $\partial_t \mathbf{A}_e = 0$

$$\mathbf{E}_e = -\nabla V_e \quad , \quad \mathbf{B}_e = \nabla \wedge \mathbf{A}_e \quad , \quad \nabla.\mathbf{A}_e + 1/c^2 \partial_t V_e = 0 \qquad (6a)$$

Then, changing **E** ,**B**, according to the tables (1,a,b) into the gravitational and cogravitational fields **g**, **K** and the subscripts e,m into g, cg gives similarly the gravilimit ($\partial_t \mathbf{A}_g = 0$) and the cogravilimit ($\partial_t V_g$) = 0

$$\mathbf{g}_g = -\nabla V_g \quad , \quad \mathbf{K}_g = \nabla \wedge A_g \quad , \quad \nabla.\mathbf{A}_g + 1/c^2 \partial_t V_g = 0 \qquad (6b)$$

$$\mathbf{g}_{cg} = -\nabla V_{cg} - \partial_t \mathbf{A}_{cg} \quad , \quad \mathbf{K}_{cg} = \nabla \wedge \mathbf{A}_{cg} \quad , \quad \nabla.\mathbf{A}_{cg} = 0 \qquad (5b)$$

The gravitational potentials have the Poisson approximation [1]

$$\nabla^2 V_g = 4\pi G \rho \qquad \nabla^2 \mathbf{A}_{cg} = 4\pi G \mathbf{J}/c^2 \qquad (7)$$

So, the gravilimit supplies the newtonian gravitation generalized by the existence of the co-gravitational field **K** in accordance with the Heaviside suggestion [5].

Remark : It has been proved [6] that E_g may be expressed in terms of a vector potential and K_{cg} in terms of a scalar potential.

4. CONCLUSION

The generalization of the basic gravitational equation of General Relativity theory is based at a large extent on the existence of the cogravitational field. Many applications of this gene-ralized gravity may be found in the Jefimenko books [1,7] (in a curious work [8] the advance of Mercury perihelion is explained by the cogravity).

We have proved here that the non relativistic approximation of the Jefimenko theory sup-plies in addition to a generalization of newtonian gravity (reducing in fact to newtonian gravity since the term due to the cogravitational field is very small and negligible), a second

3

non relativistic gravity. The interpretation os fhese approximations fall out of the scope of this pre esnt Note.

REFERENCES

[1] Jefimenko O.D. 1992 Causality,Electromagnetic Induction and Gravitation.Electret Scientific Company.

[2] LeBellac M, LevyLeblond.J.M .1973, Galilean electromagnetism Nuo.Cim..14B 217- 233.

[3]De Montigny M., Rousseaux G. 2OO6 On the electrodynamics of moving bodies at low velocities Eur. J.Phys.27 . 755-768.

[4] Manfredi,G 2013.Nonrelativistic limits of Maxwell's equations. Eur.J.Phys. 34, 859- 871.

[5] Heaviside O. 1893 A Gravitational and Electromagnetic Analogy. The Electrician 31 81 and 359.

[6] Jefimenko O.D. 1989 Electricity and Magnetism Electret Scientific, Star City).

[7] Jefimenko O.D. 2oo6 Gravitation and Cogravitation, Electret Scientific, Star City .

[8] De Matos, Tajmar M.. Advance of Mercury Perihelion Explained by Cogravity.arxiv.org /pdf/gr.qc/0005040