GRAVITATIONAL AND ELECTROMAGNETIC ENERGY FROM CURVED SPACE-TIME: THE UNIVERSAL GRAVITATIONAL AND ELECTROMAGNETIC ENERGY-MOMENTA OF ANTISYMMETRIZED GENERAL RELATIVITY (AGR).

by

Petar K. Anastasovski (1), T. E. Bearden (2), C. Ciubotariu (3), W. T. Coffey (4), L. B. Crowell (5), G. J. Evans (6), M. W. Evans (7, S), R. Flower (9), A. Labounsky (10), B. Lehnert (1 1), M. Mészáros (12), P. R. Molnár (12), J. K. Moscicki (13), S. Roy (14), J.-P. Vigier (15)

Institute for Advanced Study, Alpha Foundation, Institute of Physics, 11 Rutafa Street, Building H, Budapest H- 1165, Hungary

and

D. Clements, Department of Theoretical Physics and New College, Oxford.

Also at:

1) Faculty of Technology and Metallurgy, Department of Physics, University of Skopje, Republic of Macedonia.

2) CEO, CTEC Inc., 23 11 Big Cove Road, Huntsville, AL 35801-l 35 1.

3) Institute for Information Technology, Stuttgart University, Stuttgart, Germany.

4) Department of Microelectronics and Electrical Engineering, Trinity College, Dublin 2, Ireland.

5) Department of Physics and Astronomy, University of New Mexico, Albuquerque, New Mexico.

6) Ceredigion County Council, Aberaeron, Wales, Great Britain.

7) former Edward Davies Chemical Laboratories, University College of Wales, Aberystwyth SY23 1NE, Wales, Great Britain.

8) sometime JRF, Wolfson College, Oxford, Great Britain.

9) CEO, Applied Science Associates, and Temple University, Philadelphia, Pennsylvania, USA.

10) The Boeing Company, Huntington Beach, California.

11) Alfven Laboratory, Royal Institute of Technology, Stockholm, S-100 44, Sweden.

12) Alpha Foundation, Institute of Physics, 11 Rutafa Street, Building H, Budapest, H-l 165, Hungary.

13) Smoluchowski Institute of Physics, Jagiellonian University, ul Reymonta 4, Krakow, Poland.

14) Indian Statistical Institute, Calcutta, India.

15) Labo de Gravitation et Cosmologie Relativistes, Université Pierre et Marie Curie, Tour 22-12, 4 ème e/age, 4 Place Jussieu, 7525 Paris cedex 05, France.

KEYWORDS: antisymmetrized general relativity; gravitational and electromagnetic energy from curved space-time; universal gravitational and electromagnetic energy-momentum; higher symmetry electrodynamics.

ABSTRACT

Using general relativity extended by Clifford algebra (antisymmetrised general relativity (agr)) expressions are derived for the gravitational and electromagnetic energy inherent in curved space-time. By considering the interaction of one electron with the rest of the universe it is argued that the electromagnetic energy inherent in curved space-time ("universal electromagnetic energy-momentum") can be extracted by the electron and used to produce current in a circuit. An example of this principle at work is the recently patented motionless electromagnetic generator.

1. INTRODUCTION

In general relativity, [1], the symmetric canonical energy momentum tensor $T_{\mu\nu}$ is expressed in terms of Riemann geometry through Einstein's field equation:

$$G_{\mu\nu} := R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} \qquad k T_{\mu\nu} \quad - (1)$$

where $G_{\mu\nu}$ is the Einstein field tensor, k is the gravitational constant, $R_{\mu\nu}$ is the Ricci tensor, R is the scalar curvature and $g_{\mu\nu}$ *is* the metric *tensor*. Eqn. (1) is a field equation in ten unknowns, the elements of $G_{\mu\nu}$, and the equation shows that in the presence of matter, represented by the tensor $T_{\mu\nu}$, space-time becomes curved. The gravitational field is the Einstein tensor $G_{\mu\nu}$, and equation (1) shows that the field is the canonical energy-momentum of matter within a factor k. Therefore in the absence of matter ("the vacuum") the gravitational field vanishes and space-time is Euclidean - the Christoffel symbols vanish and with them the Riemann and Ricci tensor elements and the scalar curvature R. The gravitational field must originate in something, and its origin is $T_{\mu\nu}$. Equation (1) is an energy-momentum balance equation between field and matter. It follows that space-time in the universe is always Riemannian, and never Euclidean, because in an Euclidean space-time the universe would be devoid of all matter.

Equation (1) could equally well be interpreted as indicating that matter fields are the result of curved space-time. In this view there are no point particles, and the symbol m for the mass of the electron is interpreted as a fundamental magnitude in physics. The electron is therefore represented by a matter field in which there are no singularities. The gravitational field mediates the gravitational interaction between matter fields, and there is always a coupling between matter field and gravitational field [2]. The gravitational field originates in one matter field and influences another matter field. The gravitational attraction between two electrons is explained in this way. The interaction between one electron and the rest of the universe is considered similarly, the electron is subjected to the net gravitational field generated by the rest of the universe, a field that is represented by curved space-time through the Einstein tensor $G_{\mu\nu}$ generated by the rest of the universe. We refer to this as " universal gravitational energy-momentum". The energy inherent in the gravitational field $G_{\mu\nu}$ can be expressed as:

$$En_{\mu\nu}^{(s)} = \frac{1}{k} G_{\mu\nu} \qquad -(2)$$

even in regions of the universe that appear to be devoid of observable matter. These regions must be distinguished carefully from the vacuum, which in general relativity is flat space-time. In general relativity, the electron can never be entirely free of the gravitational influence of the rest of the universe and can never be free of the influence of universal gravitational energy-momentum..

By using Clifford algebra in general relativity, in particular the space-time basis defined by the Pauli matrices [1], Sachs [2] has developed a unified field theory of gravitation and electromagnetism using the principles of general relativity. We refer to this classical unified theory of fields as antisymmetrised general relativity (agr). In agr the electromagnetic field is also space-time curvature, and the electromagnetic interaction between two electrons is mediated by space-time curvature in Riemann geometry. The electromagnetic interaction between one electron and the rest of the universe becomes conceptually the same as the gravitational interaction between one electron and the rest of the universe. It follows that the electron is never free of the electromagnetic influence of the rest of the universe, the "universal electromagnetic energy-momentum". The latter produces electromagnetic energy momentum in the electron, producing charge-current density. The latter can be used to generate an observable current in a circuit. The source of this current is the canonical electromagnetic energy-momentum in the rest of the universe, and this source influences the electron through the electromagnetic field in agr. This process can be seen to work in devices such as the recently patented motionless electromagnetic generator [3]. The latter conserves energy-momentum and charge-current density in the universe, defined as the electron and the rest. On the simplest conceptual level, the motionless electromagnetic generator can be explained as a device that transforms the universal electromagnetic energy-momentum into a measurable current in a circuit.

2 EXTRACTION OF UNIVERSAL ELECTROMAGNETIC ENERGY-MOMENTUM BY ONE ELECTRON.

Consider one electron interacting with the universal gravitational and electromagnetic energy-momenta in antisymmetrized general relativity [2, 4-8]. These energy-momenta are represented by the four vector T_ρ in the Clifford algebra defined by

Sachs [2]. From T_ρ form the symmetric and anti-symmetric tensors:

$$T^{(S)}_{\rho\gamma} = T_\rho q^*_\gamma + q_\gamma T^*_\rho \quad — (3)$$

$$T^{(A)}_{\rho\gamma} = T_\rho q^*_\gamma - q_\gamma T^*_\rho \quad — (4)$$

where q_γ is the metric four vector of agr [2 4-8] and where q^*_γ is its quaternion conjugate, obtained from q_γ by reversing the sign of the space indices. Therefore in covariant-contravariant notation $q^*_\gamma = q^\gamma$.

In agr the gravitation field due to T_ρ is the symmetric (Einstein) tensor:

$$G^{(S)}_{\rho\gamma} = k T^{(S)}_{\rho\gamma} \quad — (5)$$

and the electromagnetic field due to T_ρ is the anti-symmetric tensor:

$$G^{(A)}_{\rho\gamma} = Q k T^{(A)}_{\rho\gamma} \quad — (6)$$

where Q is the Sachs constant with the units of magnetic flux (weber) [4-8]. The units of Q are therefore expressible as multiples of $\hbar / e$ (the elementary fluxon. where $\hbar$ is the Dirac constant and e the charge on the proton (the negative of the charge on the electron)).

The charge-current density produced in one electron by the universal electromagnetic energy-momentum is:

$$J_\gamma = D^\rho G_{\rho\gamma}^{(A)} \quad -(7a)$$

$$= Q k D^\rho \left(T_\rho q_\gamma^{*} - q_\gamma T_\rho^{*} \right) \quad -(7b)$$

where D^ρ denotes the covariant derivative of Riemann geometry [2]. Equation (7a) is the inhomogeneous field equation of electromagnetism in agr. The accompanying homogeneous field equation is the Jacobi identity [2]:

$$D_\rho \tilde{G}^{\rho\gamma(A)} := 0$$

$$:= D_\lambda G^{\rho\gamma(A)} + D_\gamma G^{\lambda\rho(A)} \quad D\, G^{\gamma\lambda(A)} \quad -(8)$$

where $\tilde{G}^{\rho\gamma(A)}$ is the dual of $G_{\rho\gamma}^{(A)}$. Eqns. (7) and (8) are not Maxwell Heaviside field equations, they are equations of agr in which space-time is always curved and in which the electromagnetic field, through eqn. (6) is a manifestation of curved space-time. Under well-defined conditions [4-8] equations (7) and (8) reduce to those of O(3) electrodynamics [2, 4-8], which is a Yang-Mills gauge field theory of electrodynamics with internal gauge group symmetry O(3). It follows that O(3) electrodynamics is also a theory of general relativity. Maxwell Heaviside field theory is a Yang Mills gauge field theory with internal gauge group symmetry U(1) [1] and Maxwell Heaviside theory is a theory of special relativity (Euclidean space-time). The O(3) group has a higher symmetry content (e.g. more (three) group structure constants) than the U(1) group (one), and so O(3) electrodynamics and agr, from which it can be derived are referred generically as theories of "higher symmetry electrodynamics". It follows that there is no universal electromagnetic energy-momentum in

Maxwell Heaviside field theory, because space-time is flat.

The charge current density of the electron on the left hand side of equation (7) is obtained from the universal electromagnetic energy-momentum on the right hand side. Eqn. (7) describes a transfer of electromagnetic energy-momentum to the electron from the rest of the universe, a transfer which takes place in curved space-time. In this process the total energy-momentum and charge-current density in the universe is conserved and Noether's Theorem [1] therefore applies. The universal gravitational and electromagnetic energy-momenta are transferred to the electron by the field tensors $G^{(S)}_{\rho\gamma}$ and $G^{(A)}_{\rho\gamma}$ respectively, defined in agr by [2]:

$$G^{(S)}_{\rho\gamma} = \frac{1}{4}\left(K_{\rho\lambda} q^{\lambda} q_{\gamma}^{*} - q_{\gamma} q^{\lambda *} K_{\rho\lambda} + q^{\lambda} K^{+}_{\rho\lambda} q_{\gamma}^{*} - q_{\gamma} K^{+}_{\rho\lambda} q^{\gamma *}\right) + \frac{1}{8}\left(q_{\rho} q_{\gamma}^{*} + q_{\gamma} q_{\rho}^{*}\right) R \qquad -(9)$$

$$G^{(A)}_{\rho\gamma} = Q\left(\frac{1}{4}\left(K_{\rho\lambda} q^{\lambda} q_{\gamma}^{*} + q_{\gamma} q^{\lambda *} K_{\rho\lambda} + q^{\lambda} K^{+}_{\rho\lambda} q_{\gamma}^{*} + q_{\gamma} K^{+}_{\rho\lambda} q^{\lambda *}\right) + \frac{1}{8}\left(q_{\rho} q_{\gamma}^{*} - q_{\gamma} q_{\rho}^{*}\right) R\right) \qquad -(10)$$

where $K_{\rho\lambda}$ is the spin curvature tensor defined by the four curl of spin affine connections [2] which can be constructed from the Christoffel symbols of Riemann geometry.

The gravitational energy momentum in the field tensor $G^{(S)}_{\rho\gamma}$ is defined by:

$$En^{(S)}_{\rho\gamma} = \frac{1}{R} G^{(S)}_{\rho\gamma} \qquad -(11)$$

and the electromagnetic energy momentum in the tensor $G^{(A)}_{\rho\gamma}$ is defined by:

$$En^{(A)}_{\rho\gamma} = \frac{1}{Qk} G^{(A)}_{\rho\gamma} \quad -(12)$$

Fromeqns. (7) and(12) it is seen that the electron is always influenced by the universal electromagnetic energy-momentum, which produces in the electron the charge-current density:

$$J_\gamma = Qk\, D^\rho En^{(A)}_{\rho\gamma}. \quad -(13)$$

The electron continues indefinitely to receive universal electromagnetic energy momentum without violation of Noether's Theorem. From eqn. (13) the current density (for example in a circuit) produced by the electron is:

$$J_i = Qk\, D^\rho En^{(A)}_{\rho i} \quad -(14)$$

where i = 1, 2, 3 denotes space indices.

So in a device such as the motionless electromagnetic generator [3] , the current is produced by $En^{(A)}_{\rho i}$, which is curvature of space-time through eqns. (12) and (10). The transfer of curvature to current in a circuit continues indefinitely without violation of the laws of conservation of energy-momentum and charge-current density. This is observed experimentally in the MEG {3}, in which a current continues to be measurable when there is no apparent electromotive force, i.e. when the battery used to start it up is switched off a current continues to be observable.

REFERENCES

[1] L. H. Ryder, Quantum Field Theory, (Cambridge University Pres, 2nd ed., 1987, 1996).

{2} M. Sachs in M. W. Evans (ed.), “Modern Non-linear Optics” a special topical issue of Advances in Chemical Physics, (Wiley Inter-science, New York, 2001, 2nd ed.), vol 119(1).

{3} T. E. Bearden in ref. (2), vol. 119(2) and U.S. Patent no. 4 details: www.cheniere.org.

{4} M. W. Evans, J.-P. Vigier, S. Roy and S. Jeffers, The Enigmatic Photon (Kluwer, Dordrecht, 1994 to 2002, hardback and paperback) in five volumes. www.aias.us.

{5} M. W. Evans and L. B. Crowell. “Classical and Quantum Electrodynamics and the $B^{(3)}$ Field” (World Scientific, Singapore, 2001). www.aias.us.

{6} T. W. Barrett, L. B. Crowell, M. W. Evans, D. Reed, B. Lehnert, and other authors, reviews on higher symmetry electrodynamics in ref. (2), vols. 119(1), 119(2) and 119(3). www.aias.us

{7} D. Clements and M. W. Evans, Phys.Lett. A to be submitted, (a perturbation solution of agr for the $B^{(3)}$ field). www.aias.us

{8} M. W. Evans et al., an AIAS paper on the derivation of the inverse Faraday effect from agr, Found.. Phys. Lett., in press, 2003. www.aias.us