

Chapter 18

Explanation Of The Faraday Disc Generator In The Evans Unified Field Theory

by

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Abstract

The Evans unified field theory is used to give a straightforward explanation of the Faraday disc generator in general relativity using Cartan geometry instead of Riemann geometry. The electromagnetic field tensor is the torsion tensor, which in differential geometry becomes the torsion form. The Faraday law of induction is shown to hold in any frame of reference, and a torsion is set up mechanically in the Faraday disc generator. This mechanically induced spacetime torsion is the cause of the electric induction observed in the Faraday disc when the magnet is stationary. The unified field theory explains observed electric induction by a solenoid in a wire loop. Magnetic lines of force are contained within the solenoid

and electric induction occurs through the spin connection of general relativity. In special relativity there is no spin connection and no explanation for electric induction by a solenoid. There are several effects now known to be explicable by the Evans unified field theory of general relativity but not by the Maxwell-Heaviside field theory of special relativity.

Key words: Evans unified field theory, Faraday disc generator, electric induction by a solenoid.

18.1 Introduction

Recently [1]– [25] a unified field theory has been developed and based rigorously on the principles of Einsteinian general relativity. The original field theory of Einstein and Hilbert, developed independently [26]– [28] in 1915 used Riemann geometry and was applicable only to central forces in gravitation. In 1922 Cartan [29] suggested that the electromagnetic field might be his newly inferred torsion form, but despite the well known correspondence between Cartan and Einstein a unified field theory based on Cartan geometry did not emerge. This might have been due to the fact that the understanding of non-linear optics [1]– [25] necessary for a unified field theory was not available to Cartan and Einstein. If the torsion form of Cartan [26] is to be the electromagnetic field then there must exist the fundamental Evans spin field $\mathbf{B}^{(3)}$ observed in the inverse Faraday effect [1]– [25] and inferred by Evans in 1992 [30]. The inverse Faraday effect (now routinely observable) was not inferred until the mid fifties by Piekara and Kielich [1]– [25] and was not observed experimentally until the mid sixties [31]. The Evans spin field is an intrinsic part of the Cartan torsion tensor multiplied by a scalar valued potential $A^{(0)}$, and the Evans spin field is now known to be responsible for the inverse Faraday effect, which is the magnetization of matter by circularly polarized electromagnetic radiation at any frequency. The spin field is generated by the term $\omega^a_b \wedge A^b$, where ω^a_b is the spin connection of Cartan and where A^b is the potential one-form [1]– [25] of the Evans field theory. It is shown in Section 18.2 that for electromagnetism the spin connection is always dual to the Cartan tetrad q^a , which defines the potential one form as follows:

$$A^a = A^{(0)} q^a. \quad (18.1)$$

This inference leads to the well established expression [1]– [25] for the Evans spin field in vector notation:

$$\mathbf{B}^{(3)*} = -i \frac{\kappa}{A^{(0)}} \mathbf{A}^{(1)} \times \mathbf{A}^{(2)} \quad (18.2)$$

using the complex circular basis ((1), (2), (3)). Here κ is the wavenumber:

$$\kappa = \frac{\omega}{c} \quad (18.3)$$

where ω is the angular frequency of the radiation and where c is the speed of light. The spin field is therefore an ineluctable result of the fact that in general

relativity and the Evans field theory, electromagnetism is spinning spacetime in which the spin connection must be non-zero. In the Maxwell-Heaviside field theory the frame is passive and there is no spin connection and no inverse Faraday effect. General relativity is preferred because a theory of physics must always be objective to all observers, and general relativity is indicated by the experimental data. Without empiricism (extraneous to the Maxwell-Heaviside field theory) there is no explanation for the inverse Faraday effect in special relativity.

In Section 18.3 it is shown that the Faraday law of induction in Cartan geometry is the same in all frames of reference because the spin connection for rotational motion is always dual to the tetrad form. In consequence the Riemann form [1]– [26] is always dual to the torsion form for rotational motion and the Faraday law of induction in consequence is always:

$$(d \wedge F^a)_1 = (d \wedge F^a)_2 = 0 \quad (18.4)$$

where the subscripts denote frames 1 and 2. In the presence of mechanically induced torsion (such as that in the Faraday disc), the total electromagnetic two-form is the sum:

$$F^a = F^a_1 + F^a_2 \quad (18.5)$$

where F^a_1 is the intrinsic (frame 1) component and where F^a_2 is the component induced by mechanical torsion (frame 2 component). The complete Faraday law of induction is therefore part of the expression:

$$d \wedge F^a = 0. \quad (18.6)$$

Thus mechanical torsion as in the Faraday disc generator [32]– [36] induces an extra electromagnetic two-form. The latter also obeys the Faraday law of induction in frame 2, so:

$$(d \wedge F^a)_2 = 0. \quad (18.7)$$

In special relativity the electromagnetic field is thought of as an entity separate from spacetime superimposed on a passive or static frame, so in special relativity mechanical torsion does not result in electric induction, contrary to the experimental data given by the Faraday disc generator. As for the inverse Faraday effect, general relativity and the Evans unified field theory are preferred.

In Section 18.4 the unified field theory is used to give a third example of the fact that in classical electrodynamics, general relativity is preferred to special relativity. This is electric induction by a solenoid that encloses the magnetic field. If a wire loop is placed outside the solenoid electric induction is observed [32]– [36] contrary to Maxwell-Heaviside field theory (i.e. special relativistic electrodynamics). In the region occupied by the wire loop:

$$\mathbf{B} = \mathbf{0} \quad (18.8)$$

where \mathbf{B} is the magnetic flux density enclosed inside the solenoid. Therefore in the Maxwell-Heaviside field theory there should be no electric induction. The

Faraday induction law of that theory is:

$$\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = \mathbf{0} \quad (18.9)$$

and so if $\mathbf{B} = \mathbf{0}$ there is no electric induction:

$$\nabla \times \mathbf{E} = \mathbf{0}. \quad (18.10)$$

This result is contrary to the data [32]– [36] . In Section 18.4 it is shown that the observed induction is due to the spin connection term $\omega^a_b \wedge A^b$, as for the inverse Faraday effect, and also the Aharonov Bohm effects [1]– [25]. The electromagnetic form in the Evans field theory of Einsteinian general relativity is defined by the first Cartan structure equation and is:

$$F^a = d \wedge A^a + \omega^a_b \wedge A^b \quad (18.11)$$

where $d \wedge$ is the exterior derivative. In the Maxwell-Heaviside field theory of special relativity the electromagnetic form is defined by:

$$F = d \wedge A \quad (18.12)$$

and the spin connection term is missing because the frame is passive or static. The confined magnetic flux density inside the solenoid is defined by the $d \wedge A$ term in Eq.(18.11), but outside the solenoid there exists the term $\omega^a_b \wedge A^b$, which produces the experimentally observed [32]– [36] electric induction through the equation:

$$d \wedge (\omega^a_b \wedge A^b) = 0. \quad (18.13)$$

18.2 Rotational Dynamics and Cartan Geometry

The complete expression for the homogeneous electromagnetic field equation in the Evans field theory is [1]– [25]

$$d \wedge F^a = \mu_0 j^a \quad (18.14)$$

where the homogeneous current three-form is defined by:

$$j^a = \frac{A^{(0)}}{\mu_0} (R^a_b \wedge q^b + T^b \wedge \omega^a_b). \quad (18.15)$$

Here μ_0 is the S. I. vacuum permeability. This expression is one in two variables only, the spin connection and the tetrad, because the Riemann and torsion forms are always defined in terms of them by the two Cartan structure equations [26] as follows:

$$T^a = D \wedge q^a = d \wedge q^a + \omega^a_b \wedge q^b \quad (18.16)$$

$$R^a_b = D \wedge \omega^a_b = d \wedge \omega^a_b + \omega^a_c \wedge \omega^c_b. \quad (18.17)$$

If the spin connection is dual to the tetrad:

$$\omega^a_b = \kappa \epsilon^a_{bc} q^c \quad (18.18)$$

it follows from Eqs.(18.16) and (18.17) that the Riemann form is dual to the torsion form:

$$R^a_b = \kappa \epsilon^a_{bc} T^c. \quad (18.19)$$

Here ϵ^a_{bc} is the rank three totally antisymmetric unit tensor in the tangent spacetime of Cartan geometry, a Minkowski spacetime with metric η_{ab} [1]– [26]. Thus:

$$\epsilon^a_{bc} = \eta^{ad} \epsilon_{dbc}. \quad (18.20)$$

From Eqs.(18.18) and (18.19) in Eq. (18.15):

$$j^a = \frac{A^{(0)}}{\mu_0} \kappa \epsilon^a_{bc} (T^c \wedge q^b + T^b \wedge q^c). \quad (18.21)$$

For $a = 1$ for example:

$$\begin{aligned} j^1 &= \frac{A^{(0)}}{\mu_0} \kappa (\epsilon^1_{23} T^3 \wedge q^2 + \epsilon^1_{32} T^2 \wedge q^3 + \epsilon^1_{23} T^2 \wedge q^3 + \epsilon^1_{32} T^3 \wedge q^2) \\ &= 0 \end{aligned} \quad (18.22)$$

because:

$$\epsilon^1_{23} = -\epsilon^1_{32} \quad (18.23)$$

and similarly:

$$j^a = 0, \quad a = 0, 1, 2, 3. \quad (18.24)$$

Therefore the homogeneous current vanishes when the spin connection is dual to the tetrad.

For space indices (using Eq.(18.20)) :

$$\omega_{ij} = -\frac{\omega}{c} \epsilon_{ijk} q^k, \quad i = 1, 2, 3. \quad (18.25)$$

The tetrad components are cartesian vector components [1]– [25] within a phase factor and so $e^{i\phi}$ are antisymmetric tensor components or spin generator components dual to axial vector components. This is always true for any kind of rotational motion [1]– [26], [37] so it is concluded that the spin connection for rotational motion is always dual to the tetrad for rotational motion and that the Riemann form for rotational motion is always dual to the torsion form for rotational motion. This means that Eq.(18.14) simplifies to:

$$d \wedge F^a = 0 \quad (18.26)$$

if the torsion giving rise to electrodynamics is generated by a pure rotational dynamics.

This is the case when electrodynamics is assumed to be free from any type of gravitational influence (translational or central dynamics). If gravitation influences electromagnetism (i.e. if translation or curving influences rotation or spinning) then the duality relations (18.18) and (18.19) are no longer true in general and the homogeneous current may be non-zero in general. A violation of the Faraday law of induction may therefore be observable if and when very intense gravitation influences electromagnetism. Whether such an influence exists in nature must be determined experimentally - perhaps using cosmology but perhaps such effects occur at a one electron level in suitable circuits and so may be observed in the laboratory. The electron induces considerable spacetime curvature.

The well known 1915 theory of Einstein and Hilbert corresponds to:

$$R^a{}_b \wedge q^b = 0 \quad (18.27)$$

$$T^a = 0 \quad (18.28)$$

because in the 1915 theory there is only curvature described by the Riemann tensor and the Christoffel connection:

$$\Gamma^\kappa{}_{\mu\nu} = \Gamma^\kappa{}_{\nu\mu}. \quad (18.29)$$

The torsion tensor therefore vanishes:

$$T^\kappa{}_{\mu\nu} = \Gamma^\kappa{}_{\mu\nu} - \Gamma^\kappa{}_{\nu\mu} = 0. \quad (18.30)$$

Eq.(18.27) is also the result of using a Christoffel connection, which in Riemann normal coordinates [26] leads to:

$$R_{\alpha\beta\gamma\delta} = \frac{1}{2} (\partial_\beta \partial_\gamma g_{\alpha\delta} - \partial_\alpha \partial_\gamma g_{\beta\delta} - \partial_\beta \partial_\delta g_{\alpha\gamma} + \partial_\alpha \partial_\delta g_{\beta\gamma}) \quad (18.31)$$

where $g_{\alpha\beta}$ is the symmetric metric tensor [26]. It follows from Eq.(18.31) that:

$$\begin{aligned} R_{\alpha\beta\gamma\delta} + R_{\alpha\gamma\delta\beta} + R_{\alpha\gamma\beta\delta} &= 0 \\ &= \frac{1}{2} (\partial_\beta \partial_\gamma g_{\alpha\delta} - \partial_\alpha \partial_\gamma g_{\beta\delta} - \partial_\beta \partial_\delta g_{\alpha\gamma} + \partial_\alpha \partial_\delta g_{\beta\gamma} \\ &\quad + \partial_\gamma \partial_\delta g_{\alpha\beta} - \partial_\alpha \partial_\delta g_{\gamma\beta} - \partial_\gamma \partial_\beta g_{\alpha\delta} + \partial_\alpha \partial_\beta g_{\gamma\delta} \\ &\quad + \partial_\delta \partial_\beta g_{\alpha\gamma} - \partial_\alpha \partial_\beta g_{\alpha\gamma} - \partial_\delta \partial_\gamma g_{\alpha\beta} + \partial_\alpha \partial_\gamma g_{\delta\beta}) \end{aligned} \quad (18.32)$$

which is the equivalent of Eq.(18.27) in tensor notation rather than form notation. Eq (18.32) was discovered by Ricci and Levi-Civita but is sometimes known [26] as the first Bianchi identity. In fact it is not a general identity and is true if and only if the connection is a Christoffel connection and if and only if the metric is symmetric; in which case there is a particular relation [26] between the connection and the metric. These basic facts are difficult to find in textbooks and are given here for clarity of exposition. If the connection is asymmetric in its lower two indices then:

$$R^a{}_b \wedge q^b \neq 0 \quad (18.33)$$

$$T^a \neq 0 \quad (18.34)$$

in general, and as argued gravitation may influence electromagnetism.

The second Bianchi identity:

$$D \wedge R^a_b := 0 \quad (18.35)$$

in contrast is a true identity for any type of connection because it is the Jacobi identity for covariant derivatives:

$$[[D_\lambda, D_\rho], D_\sigma] + [[D_\rho, D_\sigma], D_\lambda] + [[D_\sigma, D_\lambda], D_\rho] := 0 \quad (18.36)$$

The Jacobi identity is true for any three operators A, B and C as follows:

$$\begin{aligned} [A, [B, C]] + [B, [C, A]] + [C, [A, B]] = \\ ABC - BCA - ACB + CBA \\ + BCA - CAB - BAC + ACB \\ + CAB - ABC - CBA + BAC \\ := 0. \end{aligned} \quad (18.37)$$

18.3 Faraday Disk Generator

As discussed by Guala-Valverde et al. [32]– [36] using a series of reproducible experiments the well known Faraday disc generator is an example of Einsteinian general relativity. The original experiment by Faraday was reported in his diary on Dec 26th 1831 and consisted of a disc placed on top of a permanent magnet and separated from the magnet by paper. The assembly was suspended by a string and the complete assembly rotated. An e.m.f. was observed between the center of the disc and an edge of the disc. The e.m.f. vanished when the mechanical torsion (rotation) was absent. The effect also occurs when the magnet is rotated with respect to a stationary disc or vice versa. This experiment was part of a series of famous experiments carried out by Faraday in the year 1831, and the Faraday law of induction of the standard model (special relativistic electrodynamics) later emerged to describe the induction seen when a magnet is translated with respect to a stationary induction loop. The vector form of the law in the Maxwell-Heaviside theory was given by Heaviside.

In the Evans unified field theory [1]– [25] (generally relativistic electrodynamics) the Faraday law of induction is part of Eq.(18.26), the two homogeneous laws being:

$$\nabla \cdot \mathbf{B}^a = 0 \quad (18.38)$$

$$\nabla \times \mathbf{E}^a + \frac{\partial \mathbf{B}^a}{\partial t} = \mathbf{0}. \quad (18.39)$$

The extra index a indicates a state of polarization, and the complex circular basis [1]– [25] may be used:

$$a = (0), (1), (2), (3). \quad (18.40)$$

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Therefore a indicates transverse and longitudinal space-like states and a time-like state (0).

Although the equation (18.39) of general relativity looks similar to the familiar:

$$\nabla \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = \mathbf{0}. \quad (18.41)$$

of special relativity there is a major conceptual difference between the two. In Eq. (18.39) the phenomenon is due to the spinning of spacetime itself, in Eq.(18.41) it is due to the spinning of the field considered as an entity distinct from the passive frame. When the apparatus is spun mechanically in the Faraday disc generator there is a torsion form generated mechanically. This produces a mechanically generated electromagnetic form using the Evans Ansatz [1]– [25]:

$$F^a_{\text{mech}} = A^{(0)} T^a_{\text{mech}}. \quad (18.42)$$

The $A^{(0)}$ coefficient is a number is scalar, and originates in the magnet of the generator. If the magnet were taken away there would be no induction (spinning a metal disc about Z does not produce an e.m.f. between its center and rim, for this to occur a magnet is needed). The mechanically induced torsion is due to mechanical spin, and this spin occurs if the whole apparatus is spun, as in the original experiment of Faraday, if only the disc is spun, or if only the magnet is spun. The basic new concept at work here is that mechanical spin produces spacetime spin, and IS spacetime spin. This concept of general relativity does not occur in the Maxwell-Heaviside field theory of special relativity. The complete electromagnetic field present when there is mechanical spin is:

$$F^a_{\text{tot}} = F^a + F^a_{\text{mech}} \quad (18.43)$$

and obeys the homogeneous equation:

$$d \wedge F^a_{\text{tot}} = 0. \quad (18.44)$$

Without spin we have:

$$d \wedge F^a = 0. \quad (18.45)$$

The homogeneous equation is therefore obeyed in any frame of reference as follows:

$$d \wedge F^a_{\text{tot}} = d \wedge F^a = d \wedge F^a_{\text{mech}} = 0 \quad (18.45a)$$

and this is a direct result of Einsteinian relativity. In other words one cannot tell whether 1 is spinning with respect to 2 or vice versa - the physics is objective, the form of the equation is the same in any frame, to any observer. These concepts are missing completely from Maxwell-Heaviside (MH) theory. In consequence the MH theory runs into well known [32]– [36] problems when attempting to explain the Faraday disc generator. For example if the magnet is stationary, then:

$$\frac{\partial \mathbf{B}}{\partial t} = 0 \quad (18.46)$$

and in consequence there is no induction expected in MH theory, contrary to the data of 26th Dec., 1831. In the Evans field theory and general relativity the magnet can be stationary, but when the disc is spun, induction occurs through:

$$d \wedge F_{mech}^a = 0 \quad (18.47)$$

provided that there are two ingredients present, $A^{(0)}$ and mechanical torsion. If the magnet is aligned in Z and spun about Z with disc stationary, then again:

$$\frac{\partial \mathbf{B}}{\partial t} = 0 \quad (18.48)$$

and no induction is expected in MH theory. In the Evans field theory induction occurs through Eq.(18.47). Finally, similar arguments apply when both disc and magnet are spun about Z .

18.4 Induction By Solenoid

If a solenoid is placed inside an induction loop or coil, then electric induction is observed [32]– [36] despite the fact that the magnetic flux density \mathbf{B} is confined wholly inside the solenoid and does not reach the induction loop. In this situation:

$$\mathbf{B} = \mathbf{0} \quad (18.49)$$

and there is no induction possible in the MH theory. The explanation in the Evans field theory parallels that given earlier [1]– [25] for the well known Chambers experiment and Aharonov Bohm effects. In the Evans field theory the electromagnetic field is always defined by:

$$F^a = d \wedge A^a + \omega^a_b \wedge A^b \quad (18.50)$$

and obeys Eq.(18.26) if there is no influence of gravitation. Using the Evans Ansatz:

$$A^a = A^{(0)} q^a \quad (18.51)$$

$$F^a = A^{(0)} T^a \quad (18.52)$$

it is seen that Eq.(18.50) is a direct result of the first Cartan structure relation (18.16). Electric induction is therefore described in the Evans theory by:

$$d \wedge (d \wedge A^a) + d \wedge (\omega^a_b \wedge A^b) = 0. \quad (18.53)$$

There is local induction caused by the first term on the left hand side of Eq.(18.53) and a non-local induction caused by the second term involving the spin connection. The magnetic field component confined to the solenoid is defined as being part of:

$$F^a_{solenoid} = (d \wedge A^a)_{solenoid}. \quad (18.54)$$

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Outside the solenoid there is a component defined as being part of:

$$F^a{}_{loop} = (\omega^a{}_b \wedge A^b)_{loop} \quad (18.55)$$

This component causes electric induction through the equation:

$$d \wedge F^a{}_{loop} = 0. \quad (18.56)$$

In electrodynamics free of gravitation we have seen from Section 18.2 that:

$$\omega^a{}_b = \kappa \epsilon^a{}_{bc} q^c = \frac{\kappa}{A^{(0)}} \epsilon^a{}_{bc} A^c \quad (18.57)$$

and so:

$$\frac{\kappa}{A^{(0)}} (d \wedge (\epsilon^a{}_{bc} A^c \wedge A^b)) = 0. \quad (18.58)$$

This equation can be interpreted as a first order effect:

$$d \wedge (\epsilon^a{}_{bc} q^c \wedge A^b) = 0 \quad (18.59)$$

or as a second order effect:

$$d \wedge (\epsilon^a{}_{bc} A^c \wedge A^b) = 0 \quad (18.60)$$

and is the same in structure as the first and second order Aharonov Bohm effects in the Evans unified field theory [1]– [25]. It is seen that if A^b is transverse in Eq.(18.59) there is a transverse electric field generated around the induction coil, i.e. in vector notation

$$\nabla \times \mathbf{E} \neq \mathbf{0}. \quad (18.61)$$

Acknowledgments The British Government is thanked for a Civil List pension (2005). Franklin Amador is thanked for meticulous typesetting, Hal Fox for a special issue of the Journal of New Energy, Tony Craddock, Ted Annis, John B. Hart and others for funding, and the staff of AIAS for many interesting discussions. Roy Keys is thanked for directing the attention of AIAS to the work of Jorge Guala-Valverde et al.

Bibliography

- [1] M. W. Evans, *Found. Phys. Lett.*, **16**, 367, 507 (2003).
- [2] M. W. Evans, *Found. Phys. Lett.*, **17**, 25, 149, 267, 301, 393, 433, 535, 663 (2004).
- [3] M. W. Evans, *Found. Phys. Lett.*, **18**, 139, 259 (2005).
- [4] M. W. Evans, Generally Covariant Unified Field Theory, the Geometrization of Physics (2005, preprint on www.aias.us and www.atomicprecision.com)
- [5] L. Felker, The Evans Equations of Unified Field Theory (2005, preprint on www.aias.us and www.atomicprecision.com)
- [6] M. W. Evans, The Objective Laws of Classical Electrodynamics, the Effect of Gravitation on Electromagnetism, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [7] M. W. Evans, First and Second Order Aharonov Bohm Effects in the Evans Unified Field Theory, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [8] M. W. Evans, The Spinning of Spacetime as Seen in the Inverse Faraday Effect, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [9] M. W. Evans, On the Origin of Polarization and Magnetization, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [10] M. W. Evans, Explanation of the Eddington Experiment in the Evans Unified Field Theory, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [11] M. W. Evans, The Coulomb and Ampère Maxwell Laws in the Schwarzschild Metric: A Classical Calculation of the Eddington Effect from the Evans Field Theory: *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).

BIBLIOGRAPHY

- [12] M. W. Evans, Generally Covariant Heisenberg Equation from the Evans Unified Field Theory, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [13] M. W. Evans, Metric Compatibility and the Tetrad Postulate, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [14] M. W. Evans, Derivation of the Evans Lemma and Wave Equation from the First Cartan Structure Equation, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [15] M. W. Evans, Proof of the Evans Lemma from the Tetrad Postulate, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [16] M. W. Evans, Self-Consistent Derivation of the Evans Lemma and Application to the Generally Covariant Dirac Equation, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [17] M. W. Evans, Quark Gluon Model in the Evans Unified Field Theory, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [18] M. W. Evans, The Origin of Intrinsic Spin and the Pauli Exclusion Principle in the Evans Unified Field Theory, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [19] M. W. Evans, General Covariance and Coordinate Transformation in Classical and Quantum Electrodynamics, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [20] M. W. Evans, The Role of Gravitational Torsion in General Relativity: the S Tensor, *J. New Energy* Special Issue (2005, preprint on www.aias.us and www.atomicprecision.com).
- [21] M. W. Evans (ed.), *Modern Non-Linear Optics*, a special topical issue in three parts of I. Prigogine and S. A. Rice, (series editors), *Advances in Chemical Physics* (Wiley Interscience, New York, 2001, 2nd ed.), vol. 119.
- [22] M. W. Evans and L. B. Crowell, *Classical and Quantum Electrodynamics and the $\mathbf{B}^{(3)}$ Field*, (World Scientific, 2001).
- [23] M. W. Evans, J.-P. Vigi er et alii, *The Enigmatic Photon* (Kluwer, Dordrecht, 1994 to 2002, hardback and softback), vols. 1-5.
- [24] M. W. Evans and A. A. Hasanein, *The Photomagnetron in Quantum Field Theory*, (World Scientific, 1994).

- [25] M. W. Evans and S. Kielich (eds), first edition of ref. (21) (Wiley Interscience, New York, hardback and softback, 1992, reprinted 1993, and 1997), vol. 85.
- [26] S. P. Carroll, *Lecture Notes in General Relativity* (a graduate course at Harvard, Univ California Santa Barbara and Univ Chicago, public domain, arXiv: gr - gc 973019 v1 1997).
- [27] A. Einstein, *The Meaning of Relativity* (Princeton Univ Press, 1921 - 1954 editions).
- [28] L. H. Ryder, *Quantum Field Theory*, (Cambridge Univ Press, 2nd ed., 1996).
- [29] E. R. Weisstein, *Cartan Torsion Coefficient*, (Wolfram Web Resource, 2005).
- [30] M. W. Evans, *Physica B*, **182**, 227, 237 (1992).
- [31] J. P. Van der Ziel, P. S. Pershan and L. D. Malmstrom, *Phys. Rev. Lett.*, **15**, 190 (1965); *Phys. Rev.*, **143**, 574 (1966).
- [32] J. Guala-Valverde and P. Mazzoni, *Am. J. Phys.*, **63**, 228 (1995); **64**, 147 (1996).
- [33] J. Guala-Valverde and P. Mazzoni, *Apeiron*, **8(4)**, 41 (2001).
- [34] J. Guala-Valverde, *Phys. Scripta*, **66**, 252 (2002).
- [35] J. Guala-Valverde, P. Mazzoni and R. Achilles, *Am. J. Physics*, **70**, 1052 (2002).
- [36] J. Guala-Valverde, *Apeiron*, **11**, 327 (2004) and communications to AIAS (www.aias.us and www.atomicprecision.com, 2005).
- [37] J. B. Marion and S. T. Thornton, *Classical Dynamics of Particles and Systems* (Saunders College Publishing and HBJ, New York, 1988, 3rd ed.).