Chapter 2

A Review of Einstein-Cartan-Evans (ECE) Field Theory

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2.1 Introduction

The well accepted Einstein-Cartan-Evans (ECE) field theory [1, 12] is reviewed in major themes of development from Spring 2003 to present in approximately 103 papers and volumes summarized on www.aias.us and www.atomicprecision.com. Recently a third website, www.telesio-galilei.com, has been associated with these two main websites of the theory. Additionally, these websites contain educational articles by members of the Alpha Institute for Advanced Study (AIAS) and the Telesio-Galilei Association, and also contain an Omnia Opera listing most of the collected works of the present author, including precursor theories to ECE theory from 1992 to present. Most original papers are available by hyperlink for scholarly study. It is seen in detail from the feedback activity sites of the three main sites that ECE theory is fully accepted. All the 103 papers to date are read by someone, somewhere every month, and detailed summaries of the feedback are available on www.aias.us. Additionally ECE theory has been published in the traditional manner: in four journals with anonymous reviewers, (three of them standard model journals), and is constantly internally refereed by AIAS staff. The latter are like minded professionals who have worked voluntarily on ECE theory and in the development of AIAS. Computer algebra (Maxima program) has been developed to check hand calculations of ECE theory and to perform calculations that are too complicated to carry out by hand. Therefore a review of the main themes of development and main discoveries of ECE theory is timely.

The ECE theory is a suggestion for the development of a generally covariant unified field theory based on the principles of general relativity, essentially that natural philosophy is geometry. This principle has been proposed since ancient times in many ways, but its most well known manifestation is probably the work of Albert Einstein from about 1906 to 1915, culminating in the proposal of the well known Einstein-Hilbert (EH) field equation of gravitation. This work by Einstein and contemporaries is very well known, but a brief summary is given here. After several false starts Einstein proposed in 1915 that the so called "second Bianchi identity" of Riemann geometry be proportional to a form of the Noether Theorem in which the covariant derivative vanishes of the

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canonical energy-momentum tensor. It is much less well known that in so doing, Einstein used the only type of geometry then available to him: Riemann geometry without torsion. The EH field equation follows from this proposal by Einstein as a special case:

$$G_{\mu\nu} = kT_{\mu\nu} \tag{2.1}$$

where $G_{\mu\nu}$ is the Einstein tensor, k is the Einstein constant, and $T_{\mu\nu}$ is the canonical energy - momentum tensor. Eq. (2.1) is a special case of the Einstein proposal of 1915:

$$D^{\mu}G_{\mu\nu} = kD^{\mu}T_{\mu\nu} = 0 \tag{2.2}$$

where on the left hand side appears geometry, and on the right hand side appears natural philosophy. David Hilbert proposed the same equation at about the same time using Lagrangian principles, but Hilbert's work was motivated by Einstein's ideas, so the EH equation is usually attributed to Einstein. The EH equation applies however only to gravitation, whereas ECE has unified general relativity with the other fields of nature besides gravitation. The other fundamental fields are thought to be the electromagnetic, weak and strong fields. ECE has also unified general relativity with quantum mechanics by discarding the acausality and subjectivity of the Copenhagen School, and by deriving objective and causal wave equations from geometrical first principles. The two major and well accepted achievements of ECE theory are therefore the unification of fields using geometry, and the unification of relativity and quantum mechanics. This review is organized in sections outlining the main themes and discoveries of ECE theory, and into detailed technical appendices dealing with basics. These appendices include flow charts of the inter-relation of the main equations.

In Section 2.2 the geometrical first principles of ECE theory are summarized briefly, the theory is based on a form of geometry developed [13] by Cartan and first published in 1922. This geometry is fully self-consistent and well known - it can be regarded as the standard differential geometry taught in good universities. The dialogue between Einstein and Cartan on this geometry is perhaps not as well known as the dialogue between Einstein and Bohr, but is the basis for the development of ECE theory. It is named "Einstein-Cartan-Evans" field theory because the present author set out to suggest a completion of the Einstein Cartan dialogue. This dialogue was part of the attempt by Einstein and many others to complete general relativity by developing a generally covariant unified field theory on the principles of a given geometry. For many reasons this unification did not come about until Spring of 2003, when ECE theory was proposed. The main obstacles to unification were adherence in the standard model to a U(1) sector for electromagnetism, the neglect of the ECE spin field B(3), inferred in 1992, and adherence to the philosophy of the Copenhagen School. Standard model proponents adhere to these principles at the time of writing, but ECE proponents now adopt a different natural philosophy, since it may be claimed objectively from feedback data that ECE is a new school of thought.

In Section 2.3 the main field and wave equations of ECE are discussed in summary. They are derived from the well known principles of Cartan's geometry. The gravitational, electromagnetic, weak and strong fields are unified by Cartan's geometry, each is an aspect of the same geometry. The field equations are based on the one true Bianchi identity given by Cartan, using different representation spaces. The wave equations are derived from the tetrad postulate, the very fundamental requirement in natural philosophy and relativity theory that the complete vector field be invariant under the general transformation of coordinates. To translate Cartan to Riemann geometry requires use of the tetrad postulate. Therefore both the Bianchi identity and tetrad postulate are fundamentals of standard differential geometry and their use in ECE theory is entirely standard mathematics [13].

In Section 2.4 the unification of phase theory made possible by ECE is summarized in terms of the main discoveries and points of development. The main point of development in this context is the unification of apparently disparate phases such as the electromagnetic phase, the Dirac and Wu Yang phases, and the topological phases. ECE theory presents a unified geometrical approach to each phase, and this approach also gives a straightforward geometrical explanation of the Aharonov-Bohm effects and "non-locality". The electromagnetic phase for example is developed in terms of the B(3) spin field [14] and some glaring shortcomings of the standard model are corrected. Thus, apparently simple and well known effects such as reflection are developed self-consistently with ECE, while in the standard model they are at odds with fundamental symmetry [1, 12]. The standard model development of the Aharonov-Bohm effects is also incorrect mathematically, obscure, controversial and convoluted, while in ECE theory it is straightforward.

In Section 2.5 the ECE laws of classical dynamics and electrodynamics are summarized in the language of vectors, the language used in electrical engineering. The equations of electrodynamics in ECE theory reduce to the four laws: Gauss law of magnetism, Faraday law of induction, Coulomb law and Ampère Maxwell law. In ECE theory they are the same in vector notation as in the familiar Maxwell-Heaviside (MH) field theory, but in ECE are written in a different space-time. In ECE the electromagnetic field is the spinning of space-time, represented by the Cartan torsion, while in MH the field is a nineteenth century concept still used uncritically in the contemporary standard model of natural philosophy. The space-time of MH is the flat and static Minkowski space-time, while in ECE the space-time is dynamic with non-zero curvature and torsion. This difference manifests itself in the relation between the fields and potentials in ECE, a relation which includes the spin connection.

In Section 2.6, spin connection resonance (SCR) is discussed, concentrating as usual on the main discoveries and points of development of the ECE theory. In theory, SCR is of great practical utility because the equations of classical electrodynamics become resonance equations of the type first inferred by the Bernoulli's and Euler. Therefore a new source of electric power has been discovered in ECE theory - this source is the Cartan torsion of space-time. Amplification occurs in principle through SCR, the spin connection itself being the property of the four-dimensional space-time with curvature and torsion which is the base manifold of ECE theory. It is well known [15] that these resonance equations are equivalent to circuits that can be used to amplify electric power. In all probability these circuits were the ones designed by Tesla empirically.

In Section 2.7 the utility of ECE as a unified field theory is illustrated through the effects of gravitation in optics and spectroscopy. These are exemplified by the effect of gravitation on the ring laser gyro (Sagnac effect) and on radiatively induced fermion resonance (RFR). RFR itself is of great potential utility because it is a form of electron and proton spin resonance induced not by a permanent magnet, but by a circularly polarized electromagnetic field. This is known as the inverse Faraday effect (IFE) [16] from which the ECE spin field B(3) was inferred in 1992 [17]. The spin field signals the fact that in a self consistent philosophy, classical electrodynamics must be part of a generally covariant field theory. This is incompatible with the U(1) sector of special relativity still used to describe electrodynamics in the standard model. Any proposal for a unified field theory based on U(1) cannot be generally covariant in all sectors, leaving ECE as the only satisfactory unified field theory at the time of writing.

In Section 2.8 the well known radiative corrections [18] are developed with ECE theory, and a summary of the main points of progress illustrated with the anomalous g factor of the electron and the Lamb shift. It is shown that claims to accuracy of standard model quantum electrodynamics (QED) are greatly exaggerated. The accuracy is limited by that of the Planck constant, the least accurately known fundamental constant appearing in the fine structure constant. There are glaring internal inconsistencies in standards laboratories tables of data on the fundamental constants, and QED is based on a number of what are effectively adjustable parameters introduced by ad hoc procedures such as dimensional renormalization. The concepts used in QED are vastly complicated and are not used in the ECE theory of the experimentally known radiative corrections. The Feynman perturbation method is not used in ECE: it cannot be proven to converge as is well known, i.e. needs many terms of increasing complexity which must be evaluated by computer. So ECE is a fundamental theory of quantized electrodynamics from the first principles of general relativity, while QED is a theory of special relativity needing adjustable parameters, acausal and subjective concepts, and therefore of dubious validity.

In Section 2.9, finally, it is shown that EH theory has several fundamental shortcomings. As described on ww.telesio-galilei.com EH has been quite severely criticized down the years by several leading physicists. Notably, Crothers [19] has criticized the methods of solution of EH, and has shown that uncritically accepted concepts are in fact incompatible with general relativity. These include Big Bang, dark hole and dark matter theory and the concept of a Ricci flat space-time. He has also shown that the use of the familiar but mis-named "Schwarzschild metric" is due to lack of scholarship and understanding of Schwarzschild's original papers of 1916. ECE has revealed that the use of the familiar Christoffel symbol is incompatible with the one true Bianchi identity of Cartan. This section suggests a development of the EH equation into one which is self consistent.

Several technical appendices give basic details which are not usually given in standard textbooks, but which are nevertheless important to the student. These appendices also contain flow charts inter-relating the main concepts and equations of ECE.

2.2 Geometrical principles

The ECE theory is based on the two structure equations of Cartan, and the Bianchi identity of Cartan geometry. During the course of development of the theory a useful short-hand notation has been used in which the indices are removed in order to reveal the basic structure of the equations. In this notation the two Cartan structure equations are:

$$T = D \wedge q = d \wedge q + \omega \wedge q \tag{2.3}$$

and

$$R = D \wedge \omega = d \wedge \omega + \omega \wedge \omega \tag{2.4}$$

and the Bianchi identity is:

$$D \wedge T = d \wedge T + \omega \wedge T := R \wedge q. \tag{2.5}$$

In this notation T is the Cartan torsion form, ω is the spin connection symbol, q is the Cartan tetrad form, and R is the Cartan curvature form. The meaning of this symbolism is defined in all detail in the ECE literature [1,12], and the differential form is defined in the standard literature [13]. The purpose of this section is to summarize the main advances in basic geometry made during the development of ECE theory.

The Bianchi identity (2.5) is basic to the field equations of ECE, and its structure has been developed considerably [1,12]. It has been shown to be equivalent to the tensor equation:

$$\begin{aligned} &R^{\lambda}_{\rho\mu\nu} + R^{\lambda}_{\mu\nu\rho} + R^{\lambda}_{\nu\rho\mu} \\ &\quad := \partial_\nu \Gamma^{\lambda}_{\rho\mu} - \partial_\rho \Gamma^{\lambda}_{\nu\mu} + \Gamma^{\lambda}_{\nu\sigma}\Gamma^{\sigma}_{\rho\mu} - \Gamma^{\lambda}_{\rho\sigma}\Gamma^{\sigma}_{\nu\mu} \\ &\quad\quad + \partial_\rho \Gamma^{\lambda}_{\mu\nu} - \partial_\mu \Gamma^{\lambda}_{\rho\nu} + \Gamma^{\lambda}_{\rho\sigma}\Gamma^{\sigma}_{\mu\nu} - \Gamma^{\lambda}_{\mu\sigma}\Gamma^{\sigma}_{\rho\nu} \\ &\quad\quad + \partial_\mu \Gamma^{\lambda}_{\nu\rho} - \partial_\nu \Gamma^{\lambda}_{\mu\rho} + \Gamma^{\lambda}_{\mu\sigma}\Gamma^{\sigma}_{\nu\rho} - \Gamma^{\lambda}_{\nu\sigma}\Gamma^{\sigma}_{\mu\rho} \end{aligned} \tag{2.6}$$

in which a cyclic sum of three Riemann tensors is identically equal to the sum of three fundamental definitions of the same Riemann tensors. These fundamental definitions originate in the commutator of covariant derivatives acting on a four-vector in the base manifold. The latter is four dimensional space-time with BOTH curvature and torsion [1,13]. This operation produces:

$$[D_\mu, D_\nu]V^\rho = R^{\rho}{}_{\sigma\mu\nu}V^\sigma - T^{\lambda}_{\mu\nu}D_\lambda V^\rho \tag{2.7}$$

where the torsion tensor is:

$$T^{\lambda}_{\mu\nu} = \Gamma^{\lambda}_{\mu\nu} - \Gamma^{\lambda}_{\nu\mu}. \tag{2.8}$$

The curvature or Riemann tensor cannot exist without the torsion tensor, and the definition (2.7) has been shown to be equivalent to the Bianchi identity (2.6).

The second advance in basic geometry is the inference [1,12] of the Hodge dual of the Bianchi identity. In short-hand notation this is:

$$D \wedge \widetilde{T} := \widetilde{R} \wedge q \tag{2.9}$$

and is equivalent to:

$$[D_\mu, D_\nu]_{HD}V^\rho = \widetilde{R}^{\rho}{}_{\sigma\mu\nu}V^\sigma - \widetilde{T}^{\lambda}_{\mu\nu}D_\lambda V^\rho \tag{2.10}$$

where the subscript *HD* denotes Hodge dual. From these considerations it may be inferred that the Bianchi identity and its Hodge dual are the tensor equations:

$$D_\mu \widetilde{T}^{\kappa\mu\nu} = \widetilde{R}^{\kappa}{}_{\mu}{}^{\mu\nu} \tag{2.11}$$

and

$$D_\mu T^{\kappa\mu\nu} = R^{\kappa}{}_{\mu}{}^{\mu\nu} \tag{2.12}$$

in which the connection is NOT the Christoffel connection. Computer algebra [1,12] has shown that the tensor $R^{\kappa}{}_{\mu}{}^{\mu\nu}$ is not zero in general for line elements that use the Christoffel symbol, while $T^{\kappa\mu\nu}$ is always zero for the Christoffel symbol. So the use of the latter is inconsistent with the tensor equation (2.12). Therefore the neglect of torsion makes EH theory internally inconsistent, so standard model general relativity and cosmology are also internally inconsistent at a basic level. In short-hand notation the geometry used in EH is:

$$R \wedge q = 0 \tag{2.13}$$

which in tensor notation is known as "the first Bianchi identity":

$$R^{\kappa}{}_{\mu\nu\rho} + R^{\kappa}{}_{\rho\mu\nu} + R^{\kappa}{}_{\nu\rho\mu} = 0 \tag{2.14}$$

in the standard model literature. However, this is not an identity, because it conflicts with equation (2.5), and is true if and only if the Christoffel symbol and symmetric metric are used [1,13]. Eq. (2.14) was actually inferred by Ricci and Levi-Civita, not by Bianchi. So it is referred to in the ECE literature as the Ricci cyclic equation.

In the course of development of ECE theory a similar problem was found with what is referred to in the standard model literature as "the second Bianchi identity". In shorthand notation this is given [13] as:

$$D \wedge R = 0 \tag{2.15}$$

but again this neglects torsion. In tensor notation Eq. (2.15) is:

$$D_\rho R^{\kappa}{}_{\sigma\mu\rho} + D_\mu R^{\kappa}{}_{\sigma\nu\rho} + D_\nu R^{\kappa}{}_{\sigma\rho\mu} = 0. \tag{2.16}$$

It has been shown [1,12] that Eq. (2.15) should be:

$$D \wedge (D \wedge T) := D \wedge (R \wedge q) \tag{2.17}$$

which is found by taking $D\wedge$ on both sides of Eq. (2.15). Eq. (2.17) has been given in tensor notation [1,12], and reduces to Eq. (2.16) when:

$$T^{\lambda}_{\mu\nu} = 0. \tag{2.18}$$

However, Eq. (2.18) is inconsistent with the fundamental operation of the commutator of covariant derivatives on the four vector, Eq. (2.7). So in the ECE literature the torsion is always considered self-consistently. From the fundamentals [13] of Eq. (2.7) there is no a priori reason for neglecting torsion, and in fact the torsion tensor is always non-zero if the curvature tensor is non-zero. This fact precludes the use of the Christoffel symbol, making EH theory self-inconsistent.

These are the main geometrical advances made during the course of the development of ECE theory, which is the only self-consistent theory of general relativity. It has also been pointed out by Crothers [19] that methods of solution of the EH equation are geometrically incorrect, and must be discarded. It is thought that these errors have been repeated uncritically for ninety years because few have the necessary technical ability to understand the geometry of general relativity in sufficient depth, and that the prestige of Einstein has precluded or inhibited due criticism.

2.3 The Field and wave equations of ECE theory

The wave equation of ECE was the first to be developed historically [1,12], and methods of derivation of the wave equation were subsequently simplified and clarified. The field equations were subsequently developed from the Bianchi identity discussed in Section 2.2. This section summarizes the main equations and methods of