REFUTATION OF RODRIGUES:

THE MATHEMATICAL CORRECTNESS OF DIFFERENTIAL GEOMETRY

by

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ABSTRACT

The Evans unified field theory is a well accepted and straightforward

unification scheme based on standard differential geometry. Unification has been achieved by

realizing that the electromagnetic field is spinning spacetime governed by the Maurer Cartan

structure relations of differential geometry, form which follows the well known tetrad

postulate. Within a fundamental, universal or primordial voltage the electromagnetic potential

field is the fundamental tetrad field, the electromagnetic field tensor is the torsion form and

the Evans spin field observed in the inverse Faraday effect is generated by the spin connection

of differential geometry. The first Bianchi identity produces the four laws of classical

electrodynamics unified with gravitation. The Evans field theory is well tested experimentally

and cannot be refuted mathematically unless standard differential geometry itself is refuted.

Recently Rodrigues has attempted to rebut Evans field theory by rebutting standard

differential geometry and the refutation of Rodrigues in this paper uses well known methods

to prove that Rodrigues is incorrect mathematically, an obvious result.

Keywords: Evans unified field theory; standard differential geometry.

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1. INTRODUCTION AND BACKGROUND TO DIFFERENTIAL GEOMETRY.

There are many secondary school, undergraduate and post graduate courses and textbooks available on standard differential geometry and the related subject of geometric algebra. A particularly clear recent example for the use of physicists is the graduate course given at Harvard, UC Santa Barbara and Univ Chicago by Carroll {1}. Therefore any rebuttal of standard differential geometry would have to overturn the basic mathematical work of a hundred and seventy years or more, going back to Riemann and Clifford. It seems hardly necessary therefore for a physicist to have to defend standard textbook mathematics, but in this refutation such a defense has been rendered necessary by a preprint posted by Rodrigues {2}, a preprint consisting of many pages of irrelevant polemic and meaningless, incomprehensible, abstraction. In order to deal with such material we need only cite standard differential geometry in a manner that is comprehensible to mathematicians, physicists and engineers. This is because the well accepted Evans unified field theory which has evidently {3,4} been attacked anthropomorphically by Rodrigues {2} is based directly on standard, or textbook, differential geometry. It is evidently well known { 5 } that Evans has achieved a simple type of field unification in a series of twenty six papers { 6} } initiated circa March 2003. Evans realized that electromagnetism in general relativity is spinning spacetime and is governed and unified with gravitation by the Maurer Cartan structure equations of standard differential geometry. Within a fundamental, primordial or universal voltage c h the electromagnetic potential is the fundamental tetrad one- form of differential geometry:

and the electromagnetic field is the torsion two-form defined by the first Maurer Cartan

structure relation as the covariant exterior derivative of the tetrad:

$$F_{\mu\nu}^{a} = A^{(0)} T_{\mu\nu}^{a} = A^{(0)} (d \wedge q^{a} + \omega^{a} \wedge \wedge q^{b})_{\mu\nu}.$$

$$= A^{(0)} (0 \wedge q^{a})_{\mu\nu}. \qquad -(2)$$

Here whis the spin connection of standard differential geometry, d ^ is the standard exterior derivative, and D ^ the standard covariant exterior derivative. The second Maurer Cartan structure equation defines the Riemann form {1,7-9} as the covariant exterior derivative of the spin connection. Having realized this, the four laws of classical electrodynamics have been unified with classical gravitation { 10} } using the first Bianchi identity of standard differential geometry:

$$(D \wedge T^{a})_{\mu a} = (R^{a}b \wedge q^{b})_{\mu a} - (3)$$

The second Bianchi identity:

produces the Noether Theorem of the Evans unified field theory $\{6, 10\}$. The Evans spin field, well observed experimentally $\{11, 10\}$ in the inverse Faraday effect, is generated by the spin connection through the second term of Eq. (21, 10).

The Evans field theory has evidently { 5 } been accepted as an example of a workable unification scheme of use to engineers and physicists alike, and has been cross checked mathematically in many ways { 6 }. Being standard differential geometry, it is self-checking mathematically. It has been shown to produce the equations of both classical and quantum physics in appropriate limits, as required by a unification scheme, and has also

Rodrigues {2} has attempted to "refute" the Evans theory by attacking the fundamental tetrad postulate of standard differential geometry:

in a long and meaningless polemic, one in a series of unscientific diatribes {2-4} aimed randomnly at the work of several distinguished colleagues. The tetrad postulate is at the root of differential geometry because it links the Maurer Cartan structure equations with Riemann geometry. Complete details of how this is done have already been given in the four appendices of ref. { \2 }. These appendices start with the Maurer Cartan structure equations and Bianchi identities of standard differential geometry and correctly produce from them the fundamental structure equations and Bianchi identities of standard Riemann geometry, equations of the early nineteenth century. In order to do this the standard tetrad postulate is needed, as is well known and accepted {1}. This in itself is a clear and unequivocal demonstration of the incorrectness of the Rodrigues diatribe {2} and conversely of the correctness of the tetrad postulate in its well known Palatini variation {7-9}, the most general form of the postulate used in the Evans unified field theory. The demonstrations of the correctness of the tetrad postulate have been given $\{12\}$ in all detail in the hope that they can be followed by physics undergraduates. Rodrigues ignores almost all of the Evans theory and also ignores this clear evidence of its correctness { 6, 12}. His scholarship is therefore non-existent and his work should be viewed with the type of caution with which a scholar reads a random polemic.

Details of the tetrad postulate are to be found in courses and textbooks on

for example $\{ 8, 9 \}$. Recently $\{ 13 \}$ the tetrad postulate has become the cornerstone of gravitational supersymmetry theory, in which the tetrad itself becomes the spin 3 / 2 gravitino. Among the distinguished colleagues whose work is polemicised indirectly or directly by Rodrigues (see references in {2}) are Atiyah, Singer, Wheeler, Witten, Green, and anyone who uses differential geometry and the tetrad postulate (many thousands of authors). This diatribe {2} is based on a type of abstraction that can never be of interest to physics or mathematics. Therefore all that is needed to refute Rodrigues {2} is to cite the standard derivation of the tetrad postulate as given, for example, by Carroll {1}. The latter's work has also been polemicised by Rodrigues {2} but Carroll { 14 } has chosen not to respond, presumably on the grounds that Rodrigues {2} is incorrect and unscholarly. No attempt is made in this paper to go into the abstraction {2} because ref { \delta \} has already shown it to be incorrect. If abstraction does not reduce to well known and universally accepted mathematics (in this case differential geometry and Riemann geometry) the abstraction is meaningless to science. Contemporary courses, contemporary scientific papers and textbooks {7-9} reinforce this conclusion. Rodrigues' characteristic abstraction is therefore an unscientific contrivance, and this paper once again demonstrates the reason why through the use of simpler, less abstract, but correct mathematics. Rodrigues is therefore allowed to publish defamatory polemic in "scientific" journals.

In Section 2 the derivation of the standard tetrad postulate is given in terms that should be comprehensible to physics undergraduates. Some of the basic concepts of differential geometry needed for the tetrad postulate are first cited from a recent physics course by Betschinger given at M.I.T. in the Spring Semester of 2002 { 7 }.

Section 3 shows that whenever Rodrigues happens to use mathematics which can be understood by scientists he can be shown to be incorrect in one or two lines, and therefore has no scientific credibility.

2. A SIMPLE PROOF OF THE TETRAD POSTULATE.

A vector basis is orthonormal $\{1,7\}$ if its dot product is given by the Minkowski metric at any point X in a base manifold. It is always possible to choose an orthonormal basis at any point X in a given manifold and there are infinitely many orthonormal bases at X related to each other by a Lorentz transform. This defines the tangent bundle at any point X. The orthonormal basis defines the four vector V^{\bullet} , and the same vector in the base manifold (Evans spacetime $\{b\}$) is denoted V^{\bullet} . The tetrad Q^{\bullet} is defined as the matrix connecting V^{\bullet} and V^{\bullet} :

$$\nabla^a = \nabla^a \nabla^a - (6)$$

The tetrad is a vector valued one-form {1} and is always defined by Eq. (6). It is not therefore an unconstrained covariant four vector for each index a and its covariant derivative therefore cannot be defined solely by the Christoffel connection { 15}:

The covariant derivative of the tetrad must be defined both by the Christoffel connection and the spin connection through the tetrad postulate:

$$0_{\mu} q_{\lambda}^{a} = \partial_{\mu} q_{\lambda}^{a} + \omega_{\mu b} q_{\lambda}^{b} - \Gamma_{\mu \lambda} q_{\mu}^{a} = 0$$

$$-(8)$$

in its most general form (the Palatini variation). If basis elements $\ell_{\mathbf{a}}$ are defined in the tangent bundle spacetime and basis elements $\ell_{\mathbf{a}}$ are defined in the base manifold then

these are also related by the tetrad:

It is shown in this Section that Eq. (%) is a direct consequence of Eqs. (%) and (%).

Consider the vector field in the tangent bundle:

and the same vector field in the base manifold:

$$X = X^{n}e_{n} \cdot - (1)$$

The corresponding covariant derivatives are:

and

Therefore the covariant derivative of the contravariant vector X has been defined by the Christoffel connection:

$$0_{\mu} \times = 0_{\mu} \times + \Gamma_{\mu\lambda} \times - (14)$$

and the covariant derivative of the vector X has been defined by the spin connection:

The basis elements are connected by the tetrad as follows:

Using the commutator rule we may develop Eq. (13) as follows:

Now switch the dummy indices σ to \sim and use

$$\sqrt{a} \propto \frac{a}{a} = 1 \qquad -(18)$$

to obtain:

Compare Eqs. (λ) and (λ) to obtain:

and multiply both sides of Eq. (λ°) by $\sqrt{\sim}$ to obtain the tetrad postulate:

Quod erat demonstrandum.

3. REFUTATION OF TRIVIAL ERRORS BY RODRIGUES

An analysis of the thirty three page diatribe {2} shows characteristic trivial errors. In this section we confine ourselves to a refutation of two of these. This is sufficient to show that Rodrigues is not a competent mathematician. The first error is his assertion that

is "meaningless". Unfortunately for Rodrigues the expression () can be expanded to give:

whereupon it is seen that the first term on the right hand side is the standard d'Alembertian operator { \5}. This is the first time that the d'Alembertian has been described as meaningless. The second trivial error dealt with here is to assert that the definition of the wedge product of tetrads by Evans is somehow "non-standard". It is not clear whether Rodrigues goes so far as to assert that the wedge product used by Evans is incorrect. If so then the whole of standard differential geometry is incorrect because Evans uses precisely the same wedge product as Carroll {1} and all competent mathematicians. That this is so is already evident in the works by Evans { 6 } which Rodrigues pretends to "criticise". Therefore it becomes glaringly apparent that Rodrigues has not read the work he is "criticising".

In his zeal to reduce Evans to rubble, Rodrigues has self destructed. This is not an entirely unwelcome development to scientists on the receiving end of his printed tirades.

ACKNOWLEDGMENTS

The Ted Annis Foundation, Craddock Inc and John B. Hart and others are thanked for funding, and also the U. S. Department of Energy is thanked for funding experiments on the Evans theory. The Fellows and Emeriti of AIAS and others are thanked for many interesting discussions.

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