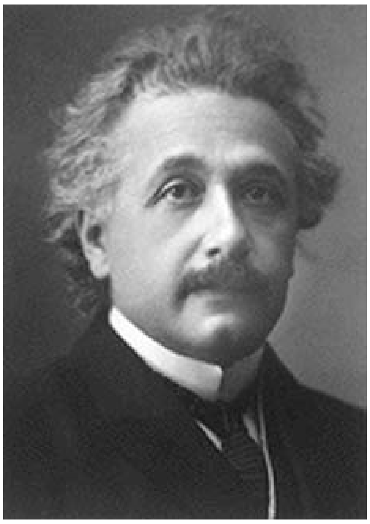

Albert Einstein **Elie Cartan** **Myron W. Evans**[1]

Einstein, Cartan and Evans – Start of a New Age in Physics?

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Summary

Although physicists have struggled in vain for over a half-century to encompass all natural forces within a unified theory, chemical physicist Myron W. Evans has succeeded in the year 2003. Based on the fundamental insights of Albert Einstein and Elie Cartan, Evans' theory takes the geometry of space-time itself as the origin of all forces of Nature. As Einstein attributed gravitation to the curvature of space-time only, the new theory attributes both gravitation and electromagnetism to curvature and torsion (or twisting) of space-time. The space-time itself is considered as the mathematical description of the vacuum or aether that has impact on matter and its behavior. This leads to predictions of new physical effects which could be used to produce energy from space-time. All areas of physics including quantum physics and cosmology are changed by the new approach.

1 Photograph by Alina Hacikjana

Introduction

For centuries, physicists and philosophers sought a unified description of all phenomena of Nature. We know today that the world at the sub-microscopic quantum scale behaves very differently than our familiar macroscopic experience. In particular, theories of gravitation have been irreconcilable with quantum theory. Therefore, one expects that, if gravitation could be unified with quantum theory, wholly new insights would result. It now appears that this unification has been achieved, but not in the manner expected by previous generations of scientists. This unification predicts fundamental new effects – for example, the production of energy (or power) without need for input of other primary energy. This prediction, among others, is creating great interest in professional and scientific circles. We now review the origins of this unification.

Albert Einstein in 1915 published a theory of the gravitational interaction; he called this the theory of General Relativity, and today it provides the basis for our understanding and exploration of the cosmos at large. In 1905, Einstein had already produced the theory of Special Relativity, which rests upon the well-known postulate of “constancy of the speed of light“ in vacuum. During the last thirty years of his life, Einstein looked for a still more comprehensive unified theory which could cover all known natural forces. He spent the years from approximately 1925 to 1955 in this search, but did not reach his desired goal. Since the discovery of quantum mechanics in the 1920’s, the majority of physicists busied themselves with this, and not with General Relativity. The fact that quantum mechanics is consistent only with Special Relativity, but not with General Relativity, was overlooked or ignored. In addition, while quantum mechanics is successful in describing the electron sheath of atoms; it is not a suitable theory for the high mass-densities which occur within atomic nuclei.

Other notable progress toward unified theory in the 20th century consisted of a unification of electromagnetism with the weak nuclear force, via an extension of the formalism of quantum-mechanics. Gravitation has remained, until today, outside the Standard Model of particle physics.

In contrast, Bruchholz [13] found a unified approach by ignoring quantum mechanics and developing a geometric field theory based on General Relativity and Rainich's "already unified theory". The discrete particle values can be determined from these geometric equations. The formalism of quantum mechanics cannot be derived from the Bruchholz theory.

Elie Cartan is less well-known than Einstein. He was a French mathematician who exchanged ideas with Einstein concerning many details of General Relativity. Cartan’s original insight was that electromagnetism could be derived, via differential geometry, from the geometry of space-time – more or less in parallel with Einstein’s insight that gravitation could be derived from space-time geometry.

A successful unification, however, was not achieved by Cartan and/or Einstein. The unification was finally achieved in the year 2003 by Myron Evans [1] who, trained as a chemical physicist, brought fresh insight to the problem. Evans held several academic professorships in England and the USA, before he was forced to withdraw because of his unorthodox views, and he worked as a “private researcher“ in his homeland of Wales until his sudden death in 2019. From there, he conducted the “Alpha Institute for Advanced Study“ (AIAS), which presents his ideas to the public as a world-wide team or working-group [2]. A popular-scientific presentation is in [3]. Recently concentrating its work on energy production from the vacuum - a topic which established science avoids – the AIAS website generates large interest, as shown by the steady increase in web-page statistics on the AIAS site [4]. Many well-known universities and research establishments world-wide have visited these pages.

1 The four natural forces

To understand the importance of unification, one must start with knowledge of the quantities being unified. It is widely accepted in physics that all interactions in Nature are manifestations of four fundamental forces. We characterize these briefly as follows:

1. The seemingly separate force-fields generated by electrostatic charge and magnetism were united in the 19th century, largely by Maxwell, into what is now called electromagnetism, or the electromagnetic field.
2. The weak nuclear force is responsible for radioactive decay. According to the Standard Model of elementary particle physics, the weak interaction is mediated by the W- and Z-bosons, which are “virtual particles“. Neutrinos also are known to be involved in the weak interaction. It has been shown that the weak force is essentially the same as electromagnetism at very high energies. Thus, these two forces are said to be “already united“.
3. The strong nuclear force holds protons and neutrons together. It is carried by gluons and quarks in combination, although direct experimental proof of their existence was not achieved until recently.
4. Gravitation is the fourth fundamental force, but it does not fit with the theoretical picture of the other three, since it is regarded (after Einstein's General Relativity theory) as the curvature of space-time, which does not correspond to a classical force term. On the other hand, General Relativity today is said to have been well-tested experimentally, so that nobody doubts its validity.

2 Unification

If a unified description and formalism could be given for these four very different forces, many new theoretical insights and practical applications would result. In addition, mutually-reciprocal interactions - which today’s mainstream physics does not recognize - could then be predicted and used.

The first three fundamental forces concern quantum physics (the world “in the small“), while the fourth force (gravitation) applies on all scales, including cosmic orders of magnitude. Therefore, the underlying fundamental problem is to unify General Relativity with quantum mechanics. Conventional science has explored essentially three different pathways which might achieve this result:

1. Bringing general relativity into quantum physics. The insurmountable difficulty here is that time in quantum physics is treated as a unique continuous parameter, which is incommensurate with the quantized coordinates of distance (or spatial displacement).
2. Quantization of General Relativity. The mathematical formalism for this approach is thus far inconclusive, and unable to make reference to experimental tests.
3. Invention of a totally new theory, from which the others follow. The various “string theories” are examples, but they require un-physical high-dimensional spaces ($N>10$), and have not produced testable predictions.

The solution comes, surprisingly, in an unexpected way. By extending the Einstein theory along the lines first suggested by Cartan, Evans shows that all four fundamental forces are derivable from one extended theory. This represents the long-sought Unified Field Theory. Evans’ approach does not exactly follow any of the three above-mentioned pathways, although it is closest to the third one in the list.

3 Basis for Evans’ theory

To understand the basis of Evans’ theory, we must review the starting-point of Einstein’s relativity theory. Einstein postulated that the presence of a massive body or an energy distribution in space (which are really interchangeable, according to the famous formula $E=mc^2$) changes the geometry of space. Viewed from right-angles within a Euclidean coordinate system, it “creates” a curvature of space (or, more accurately, space-time). One can write this directly as a formula:

$$R = k\ T$$

In which R designates the (tensor of) curvature, T the (tensor of) energy-momentum density, and k is a proportionality constant. The left side of this formula is geometry, the right side is physics. Einstein thus used the geometry of curvilinear coordinates, which goes back to the mathematician Riemann. This formula implies that space-time (i.e. the three space coordinates, and time as the fourth coordinate) is a 4-dimensional continuum (or manifold) whose curvature we perceive as a force (namely gravitation).

Notably, Einstein's formula did not exploit all possible characteristics of Riemann's geometry. It turns out that R describes only the *intrinsic curvature* of the manifold; in other words, it is limited to describing vectors whose point-to-point variation lies entirely within the manifold (see Fig. 1A).

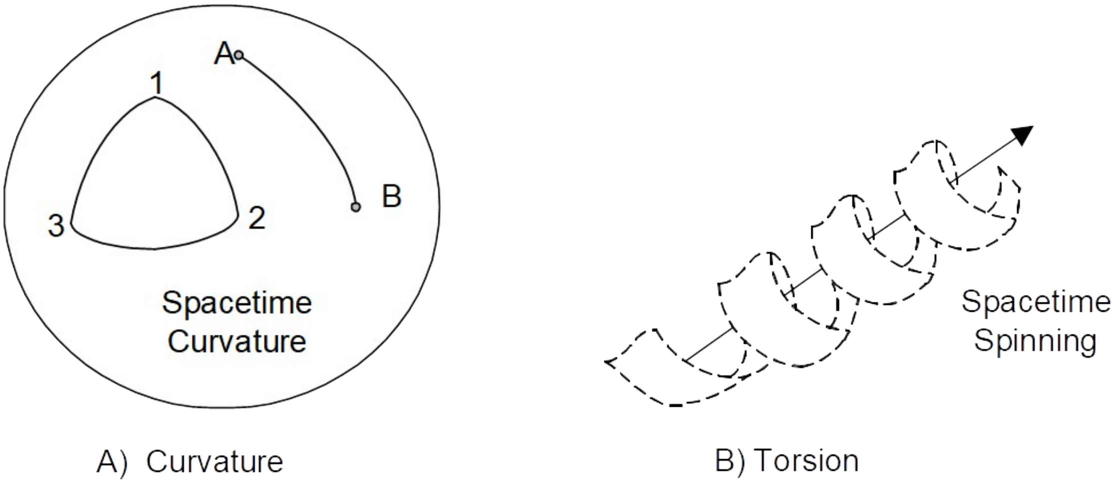

Fig. 1: Curvature and Torsion

In contrast to this, Cartan employed considerations of *extrinsic curvature*. This means that vectors are also allowed to vary within (and normal to) the plane tangential to the manifold at any point (see Fig. 1B). Cartan showed that the extrinsic curvature of space-time could be taken to represent electromagnetism as described by the Maxwell equations. Unfortunately, Einstein's use of the mathematical concept of tensors made the relation to Cartan's concept of geometry unclear. Cartan used the so-called "tetrad" to represent the manifold's extrinsic curvature. In the 3-dimensional case, this reduces to a Cartesian-coordinate "triad", which moves along with a point in space. More exactly said, the tetrad specifies a tangent space at each point of the Riemann manifold. In this way, one maintains at each point a Euclidean tangent space (a so-called fiducial space), which greatly simplifies the description and visualization of physical processes (Fig. 2).

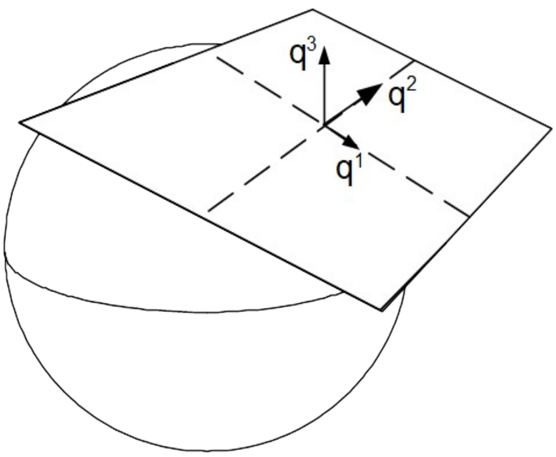

Fig.2: Tangent plane at a curved surface

Despite the value of Einstein's and Cartan's insights, a united theory could not yet be formulated, because experimental indications of how to extend Maxwell's theory in a manner consistent with General Relativity were still missing. The crucial connection was found by Evans around 1990 in the spin field or $B^{(3)}$ field.

The decisive empirical effect – the Inverse Faraday Effect (IFE), i.e. the magnetization of matter by a beam of circular-polarized electromagnetic radiation, first observed experimentally in 1964 – could not be explained by Maxwell-Heaviside electrodynamics, except by introducing an ad-hoc material property tensor or carrying out extensive solid state electronic structure calculations in presence of a magnetic field.

However, Evans in 1992 was able to derive the IFE directly from first principles (generally-covariant unified field theory, which includes general relativity), and thereby inferred the existence of a previously unknown magnetic field component – the $B^{(3)}$ field.

$B^{(3)}$ is, informally, a general-relativistic correction to classical electrodynamics, somewhat analogous to the general-relativistic correction to Newtonian gravitation needed to explain the perihelion-advance of Mercury.

The index numbers – (1), (2) and (3) -- here refer to the so-called circular basis; and the polarization directions $B^{(1)}$ and $B^{(2)}$ refer to the directions of transverse polarization of the field. Thus a polarization index must be inserted into the Maxwell equations. This polarization index corresponds to the tetrad vectors q^a in Fig. 2. Finally, this lead Evans to postulate that the geometrical representation of the electromagnetic vector-potential A should be as follows:

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

where A^a is the 4x4-matrix of the complete electromagnetic potential, and $A^{(0)}$ is a proportionality factor. The electric and magnetic fields (combined into the tensor F^a of the total electromagnetic field) then emerge directly from Cartan's expression for the torsion T^a:

$$F^a = A^{(0)}\, T^a .$$

In this formalism, electrodynamics is completely attributed to the geometrical torsion of space-time. Alternatively, the electromagnetic field can be defined by a curvature vector relating to an orbital motion (R(orbital)) or spin / self-rotating motion (R(spin)). These denominations are derived from the two ways a particle (for example an electron) can rotate around a central mass. The electric field E and magnetic field B have two polarization indices in this case as have the curvature vectors:

$$E^a{}_b = c\, W^{(0)}\, R^a{}_b(\text{orbital}),$$

$$B^a{}_b = W^{(0)}\, R^a{}_b(\text{spin}),$$

where c is the velocity of light and $W^{(0)}$ is a constant similar to $A^{(0)}$. Both definitions – via the tetrad or via the curvatures – are equivalent. The second definition associates the electric field with motion without spin while the magnetic field is associated with spinning of space-time. The polarization indices can be removed in both cases for standard usage of electrodynamics.

So far we have described how electromagnetic fields are defined from geometry. The same two methods above can be used to describe the gravitational field by axioms. The constants $A^{(0)}$ and $W^{(0)}$ are replaced by suitable other constants changing the geometric torsion and curvature into physical gravitational fields. In standard physics only the gravitational force field is known which is equivalent to the electric field. It can directly be seen by comparison with geometry that there must also be a counterpart to the magnetic field, called the gravitomagnetic field, which occurs when masses are moved or rotated. This is in analogy to a magnetic field, which appears when charges are moved or rotated.

The complete picture, unifying electromagnetism with gravitation, requires both Riemann curvature and Cartan torsion. This is described in detail by suitable field equations in form of Riemann-Cartan geometry. This theory is now called Einstein-Cartan-Evans (ECE) theory, after the names of its principal authors. For the second type of definitions – the definition of fields by curvature – the term ECE2 theory was coined.

4 Unification with strong and weak forces

Still to be described is how the remaining two fundamental forces are represented in the ECE theory.

If one analyzes the equations of the theory, it is noticeable that it is formulated for the tangent space of the Riemann manifold. The number of basis vectors of this space can be selected freely, it needs not be four-dimensional. Thereby the possibility is offered of selecting such bases which are suitable for the description of quantized action (e.g. electron spin). Furthermore Evans derived from Cartan geometry a wave equation, which is in principle a nonlinear eigenvalue equation. Under certain approximation assumptions. this equation becomes linear and predicts discrete stable states. Those are the "quanta" of energy-momentum in quantum mechanics.

All quantum-mechanical theories, in particular Dirac's electron theory, and the strong and weak interactions, can be deduced in this way as special cases of the ECE theory. These quantum-mechanical theories contain spin states, one says there is a "spin up" and "spin down" wave function. Dirac used 8x8 matrices in his equation. Evans has shown that this structure can significantly be simplified by only using 4x4 matrices which represent the spin states directly.

The theoretical basis of weak interaction is described only at few places in literature, for example by Ryder [8]. His algebra was checked by computer and found to be wholly incorrect. It was concluded that *"Ryder's Eq. (…) is wholly incorrect, a gross error that negates the whole electroweak theory and with it the Higgs boson theory. It is clear that there is no Higgs boson in nature*" [9].

Also for the strong nuclear fields, there are serious doubts if these exist in the form assumed by particle physics. There is no ab initio theory for elementary particles, what we have is a zoo of particles which can be classified phenomenologically into groups of properties called spin, colour, charme etc. The existence of quarks is hypothetical. All what exists is a highly parametrized model. From the view of ECE theory, these particles must emerge from solutions of the non-linear ECE wave equation which goes far beyond standard quantum mechanics and extends it to general relativity.

If we compare this result with the three conventional paths to unification referred to above, it is noticeable that none of these was actually used. The new theory predicts quantum effects without assuming them (as a postulate) from the beginning. The first two forces (electromagnetism and weak force) are combined, the third and fourth turn out to be derivable from other considerations, where it is unclear if a strong nuclear force really exists. In short, there are no truly "fundamental forces" because they all emerge from geometry!

5 Implications for quantum physics

The main implication is that quantum theory in its current form is not a fundamental description of Nature. In particular, the Heisenberg interpretation and the Correspondence principle are incorrect. The ECE version of quantum physics rests upon a classical, fully deterministic basis; quantum indeterminacy plays no role. Nevertheless the equations of quantum mechanics (for instance the Schroedinger equation) are correct and describe classical statistical processes. It would be a mark against ECE theory if it did not predict this result, because the equations of quantum mechanics are experimentally verified a thousand-fold.

Evans also argues that the Heisenberg uncertainty relation arose only by a misunderstanding, and is not justifiable. All physical mass-points of a field theory are actually densities – i.e. quanta of matter-energy spread over a volume of space. Thereby the Planck quantum of action is to be divided by the volume, for instance, of the measuring instrument in which two complementary variables (e.g. position and momentum) are measured. The result can become arbitrarily small, i.e. the uncertainty can be reduced to powers of ten smaller than previously believed. An elementary particle, therefore, is neither exclusively a wave, nor exclusively a particle, but possesses characteristics of both at the same time.

This sounds fantastic as a theory of physics, but exactly that was measured already some years ago [5]. The experimental refutation of the uncertainty relation was accomplished by mainstream physics.

Evans points out that torsion is always accompanied by curvature. Since curvature is manifested as gravitational mass, it follows that the spin of all elementary particles must contribute a component to their gravitational mass. From the neutrino one knows this already experimentally, even if the standard model fails here. Also photons must possess a gravitational mass, which is extremely small, however, and is situated below current detection limits.

ECE theory also brought progress in the conventional details of quantum mechanics. Evans developed the relativistic aspects of his Dirac-like wave equation in great detail and predicted new spectroscopic splittings in energy spectra of atoms and molecules. He developed the Quantum Hamilton equations that close a gap between quantum mechanics and classical theory for handling of forces.

6 Implications for electromagnetism and vacuum fields

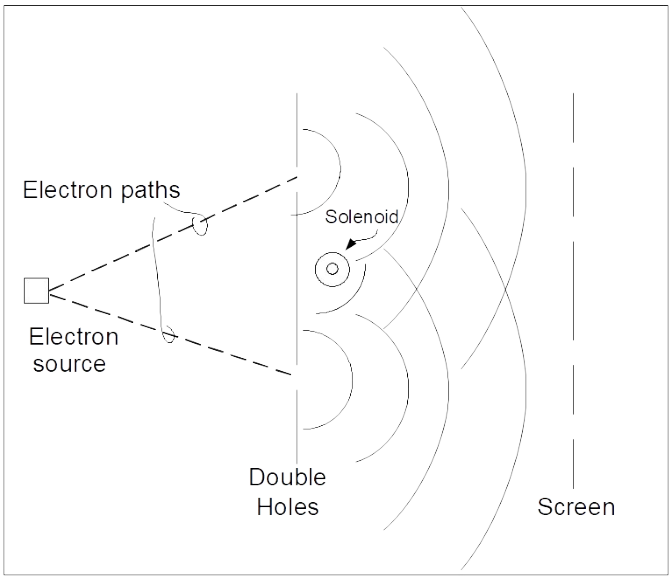

Fig.3: The Aharonov Bohm effect

As a further example of an effect which was previously difficult to explain, we consider the Aharonov Bohm effect (Fig. 3). Two electron beams are diffracted by a double slit; at the screen, a typical interference pattern is produced. In the diffraction zone is a closed toroidal coil. The magnetic field is circularly closed and thus remains within the coil. If one now switches on and off the magnetic field, in each case two different interference patterns result. The closed magnetic field thus has an effect on the electron beams, although these are not in direct contact with the coil. This appears to be a quantum-mechanical “action at a distance“, which has given rise to many confusions and unsound speculations.

This problem is treated in ECE theory as follows. The magnetic field of the coil creates a space-time “vortex” (due to its torsion) which extends into the space outside of the coil itself. The pulling effect of this vortex (i.e. the effect of vector-potential A) is then able to influence the electron beams. Thus, the apparent “action at a distance” is reduced formally to a local, causal deterministic effect. At the same time this effect proves that the vector potential is not a mere auxiliary construct for computing magnetic fields as it was considered by electromagnetic theory. Instead it has a physical meaning. The Aharonov Bohm effect sometimes is explained by classical theory which is possible, but then it is silently assumed that potentials exhibit physical effects. The same is assumed in standard quantum mechanics, without reference to the electrical engineering view. In ECE theory all potentials are interpreted in the same way.

It is possible to construct potentials without force fields. These potentials represent the flow and strain of space-time itself. Space-time is the mathematical vehicle to describe classical vacuum or aether which all three are the same in this respect.

Besides this classical vacuum, a quantum vacuum can be considered. In contrast to the classical vacuum, the latter consists of fluctuations of electromagnetic fields, in addition to fluctuating potentials. These fields are measurable by small shifts in atomic spectra (Lamb shift) for example. Evans has shown that these fluctuations originate in the spin connection which is the geometric field quantity that determines the structure of space-time.

ECE theory allows for adding spin connections for both types of vacuum to the classical equations of motion. Thus an electron in an atom as well as a celestial body moving around a gravitational center can be impacted by vacuum forces. This, for example, will result in precession of orbital ellipses (rotation of the elliptical axes).

As already mentioned, ECE theory allows polarization of electromagnetic waves in three directions of space, resolving a dilemma of electrodynamics which has to do with photon mass. If photon mass were zero as in standard theory, there can only be two directions of polarization. These are transversal modes in directions perpendicular to the propagation of the wave. The existence of photon mass – as concluded from the ECE wave equation – allows for an additional longitudinal mode in direction of wave propagation.

This is a completely new finding which fits well into the frame of ECE theory. It was shown that longitudinal modes are solutions of the field equations which are the Maxwell equations in curved and twisted space. These longitudinal waves have a remarkable property: they are standing waves a priori. It has to be stressed that standing waves normally require two fixed ends of a wave. Longitudinal electromagnetic waves, however, require only one fixed end which is the antenna. They can therefore be transmitted in any space direction without further means. In Fig. 4 an antenna for such waves is shown which may server as a transmitter as well as a receiver.

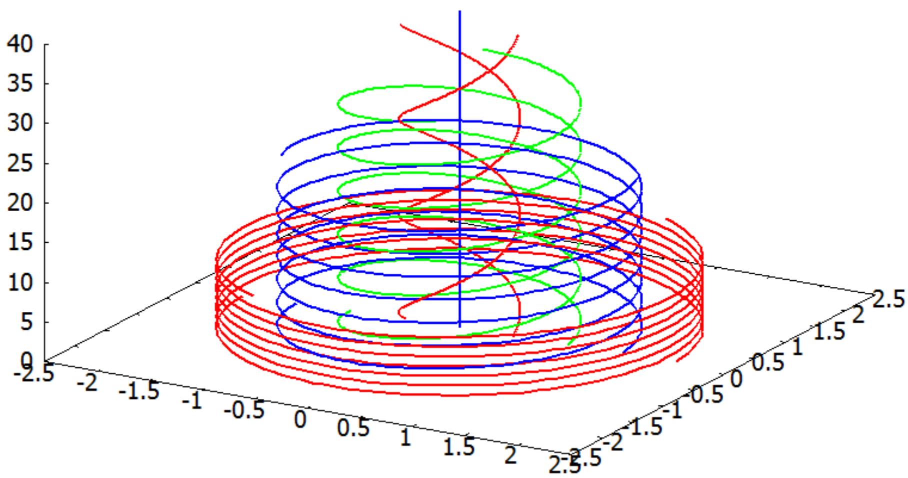

Fig.4: Antenna for longitudinal electromagnetic waves

The vacuum field may be considered as a fluid medium. The vector potential corresponds to the flow velocity field and the scalar potential to the internal pressure or strain. Therefore fluid dynamics theory (Navier Stokes equations) can be applied. Evans has shown that these are equivalent to the ECE field equations, extending the unification of fields to fluid dynamics.

7 Implications for technology

In the preceding section longitudinal electromagnetic waves were discussed. These allow point-to-point transmissions instead of spherical broadcasting and will make data transfer much more efficient.

Typically, new theories lead to practical applications only after many years. In the case of nuclear fusion, the hope of producing useful power for society's use remains unfulfilled even after 50 years. In contrast, the ECE theory suggests direct applications in diverse fields - in particular, the urgent question of energy production.

The ECE theory predicts that a gravitational field is always connected with an electrical field, and vice-versa [6]; this might be called "electrogravitics". The effect has been known empirically for decades, of course, but until now has lacked a quantitative description. That is now possible with assistance of the ECE theory. This application should interest the aircraft and space industries greatly.

In the area of electrical generators, the unipolar generator awaited an adequate explanation since its invention by Faraday in 1831. This had to be explained by the Lorentz force which is not part of the conventional Maxwell equations. Now this machine is completely explainable from the general theory [7]. Similarly as with the Aharonov Bohm effect, the torsion of space-time must be considered. In this case it is created due to the mechanical rotation.

The most interesting technical application involves the extraction of energy directly from space-time. One must understand this as a resonance effect. First the equations of ECE theory show that matter can "transduce" energy from the surrounding space-time (or vacuum). To accomplish this in practice requires that one fabricate a suitable configuration of space-time, e.g. a skillful mechanical or electromagnetic arrangement. The configuration must be so arranged that a resonant excitation of the material takes place. One knows from forced mechanical oscillations that, with suitable excitation frequency, large amounts of power can be transferred to or from the oscillating system.

Probably many "overunity" inventions on the alternative power scene function this way. In these cases, the inventors found the resonance mechanism by accident. Therefore, some experiments are not repeatable, because the fundamental mechanism and critical system parameters, which led to the desired result, are not actually known.

The ECE theory makes it possible to calculate these parameters exactly. The AIAS group is presently studying the excitation mechanism, via numerical solution of the ECE equations. Experimentally the focus is on resonance excitation in electrical circuits. If one can obtain power in this way, mechanically moving parts (as in generators) are not required; and due to the smallness of the source, each electrical appliance could, in principle, be fitted with its own power supply. The basic components would be cascadeable up to power station size.

The AIAS institute and some coworkers succeeded in explaining a device built originally by Osamu Ide [10] by a mechanism of ECE theory. Another field of energy from space-time is the low energy nuclear reactions (LENR), which awaits industrial application. The principle basis mechanism was explained by ECE theory [11].

A final application is in medical technology. Nuclear magnetic resonance (NMR) tomography requires very high magnetic fields, which forces a correspondingly complex design and construction. Instead one could use the Inverse Faraday Effect (described above) to generate the required magnetic fields in the patient. This requires only electromagnetic radiation in the radio-frequency range. Large solenoid coils are then not required, and the NMR apparatus could be built substantially smaller and cheaper.

8 Implications for cosmology

The ECE theory also has implications for astrophysics and cosmology. Expansion of the universe is conventionally said to be governed by Hubble's Law, which predicts that galaxies move away from us all the faster, the further they are distant from us. This is based on the red shift of starlight from the receding galaxies. Contrary to the received opinion, Halton Arp has found convincing arguments that quasars are not located at the border of the visible universe but within all kinds of galaxies [12]. The red shift then is totally different between the quasars and the surrounding stars. The ECE theory can explain these deviations easily. One can translate the ECE equations into a dielectric model. The reciprocal effect between radiation and gravitation is described therein by introducing a complex-valued dielectric constant. This leads to predictions of refraction of light and absorption. In areas of the universe with high mass-density, the dielectric constant is larger than in areas of low mass-density. The absorption of energy within these areas leads to an increased red shift. Such a model is totally different from the Hubble model and was already discussed as “tired light theory” tens of years ago.

The Hubble model rests upon the Einstein’s General Relativity which has been proven erroneous by Evans. In Evans’ theory, the cosmic background radiation accounts for absorbed radiation energy, and is not seen as evidence for the Big Bang, which does not occur in this model. Instead there are expanding and contracting zones of the universe adjacent to each other.

In spiral galaxies, stars on galaxy arms have nearly constant velocity which is called the “galactic curve”. This is explainable neither by classical Newtonian theory nor by Einstein’s General Relativity. By ECE theory, such a structure has been easily explained by the angular momentum of space-time. There is no need for dark matter or dark energy.

Another drawback of Einstein’s General Relativity is that nearly all cosmological solutions of that model are single-mass models, i.e. there is a central mass spanning the gravitational field. The dynamics of other masses moving in that field, including the retroaction to it, cannot be computed. Computer simulations of approximating black holes, for example, are forced to use Newtonian dynamics to describe motion of extremely massive objects.

Within ECE theory a completely new cosmology approach was developed, based on a spherically symmetric space-time. Special relativity was already introduced into classical mechanics in the twentieth century, leading to so-called relativistic Lagrange theory. Evans and coworkers have extended this theory to be capable of handling spherically symmetric, generally covariant space-time, called m theory. This advancement is at least as important as Einstein’s General Relativity. In contrast to the latter, m theory conserves energy and angular momentum and provides equations of motion which can be solved on a desktop computer. All kinds of cosmological questions like precessing, shrinking and expanding orbits, event horizons (if existing), impact of vacuum fields, up to superluminal motion, can be handled by this new cosmological theory.

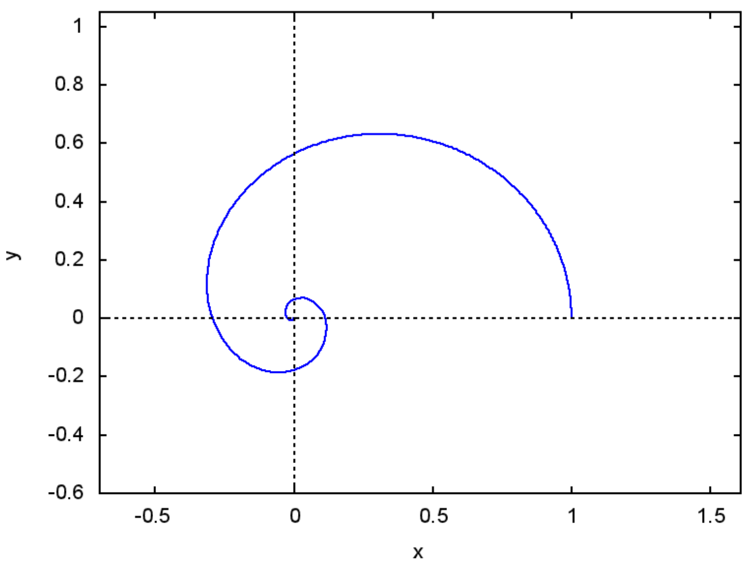

Fig.5: Motion of a mass spiraling into the gravitational center.

As an example, in Fig. 5 an orbit of a mass is graphed that falls into the centre of attraction on a spiraling curve. Such a motion can be described neither by classical mechanics nor by Einstein's Special or General Relativity.

9 Summary

The ECE theory describes a unification of the four fundamental forces, and their reciprocal interactions, in a simple unorthodox way. All physics becomes reduced to geometry. The quantum theory is placed on a causal deterministic basis, while statistical description of processes on the atomic level is preserved.

The important points of the ECE theory are the following:

1. Space-time is completely specified by curvature and torsion. All physics can be derived, via differential geometry, from these underlying primordial qualities of space-time.
2. The ECE theory is mathematically based on differential geometry. It relies exclusively on causal connections and no indeterministic processes.
3. The ECE theory rests on three sets of postulates: the curvature postulate of Einstein and the torsion/curvature postulates of Evans.
4. Torsion implies curvature, and vice-versa. Mechanics, electromagnetism and fluid dynamics can be based on this equivalence.
5. The insights of Einstein are even more penetrating than they were believed to be at first. Specifically, Einstein's views that "all physics is geometry" and that "quantum mechanics is incomplete" are correct.
6. The Copenhagen interpretation of quantum mechanics is incorrect; the abstract space of quantum theory is the tangent space of general relativity.
7. The coupling of electrodynamics with vacuum forces leads to a large number of new applications, including new sources of energy.
8. In cosmology, there is neither a Hubble Law, nor a Big Bang or dark matter. Dynamics can be calculated on base of energy and momentum conservation.

These ideas are difficult for established university scientists to digest without fundamentally re-orienting themselves. The Evans theory will receive strong impetus for further development if it actually succeeds opening new energy sources. Then these ideas will become generally accepted either with or without the support of universities and research institutes.

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