

# TOWARDS A UNIFIED FIELD THEORY

An inquiry into the connection between the fundamental axioms of general relativity and quantum mechanics- the principle of equivalence and the uncertainty principle- lead to a heretofore unsuspected mathematical relation between the two. Considering then that electrical charge is quantized in appearance only, the general field equation is thereby amended so as to accommodate an electrogravitational field, presumed to exist.

## On the Relation between the Principles of Equivalence and Uncertainty

The equivalence principle originated with Isaac Newton, who, in his early investigations of gravity, was surprised to discover that equal weights of gold and wood swung at the same pace when suspended as a pendulum. He eventually concluded that all bodies fall with the same acceleration, regardless of their internal composition. In other words, gravity does not distinguish inertia- resistance to acceleration- from rest mass. They are equivalent. From this idea he deduced that the gravitational force varies in proportion to the inverse square of the distance between two bodies.

With deep foresight, Newton also postulated that “The motion of bodies included in a given space are the same among themselves, whether that space is at rest, or moves uniformly forwards in a right line without any circular motion.” This was the rudimentary phrasing of Einstein’s principle of special relativity, which says that the laws of nature are in concordance for all inertial systems, regardless of their relative motion uniformly and rectilinearly.

Einstein soon realized that his special relativity applied only to unaccelerated frames of reference, and to express the laws of nature in an identical manner for any and all reference frames, he needed a stronger equivalence principle. Shortly after speaking with an injured house painter in 1907, he experienced an epiphany, “Because for an observer falling freely from the roof of a house there exists ‘no gravitational field’” - he has the right to interpret his state as “at rest”, along with that of any objects falling with him.

And so acceleration itself is only relative. It brings about the semblance of a body’s inertial resistance, which “can be increased by bringing unaccelerated ponderable masses in the neighborhood,” or which alternatively, “must again disappear if these masses also participate in the acceleration of the body.”

The gravitational field, then, is always acting as a free-falling laboratory. Measurements performed locally in the frame are independent of the frame’s position, time and motion. A system with “no gravitational field” is completely equivalent, as a physical framework, to one accelerating in any manner whatsoever.

The far-reaching conclusion is that space-time and matter/energy influence and even determine one another, and in the higher density regions the geometry is not Euclidean. There gravity begins to diverge from the inverse-square, becoming nonlinear.

We know from special relativity, due to the non-simultaneity of events (since signals travel no faster than light), that space and time have opposite mathematical signs in the continuum metric (i.e.  $x^2 + y^2 + z^2 - c^2t^2 = s^2$ ) and self-evidently different properties. The equivalence principle is herein suggested to be a property inherent in all four of the space-time axes, in the strict mathematical sense. It is as invariant as the measure of the continuum  $s^2$  and as the measured velocity of light *in vacuo*, irregardless of any relative motion. Equivalence retains the continuity of the 4-dimensional web, preserving the thread of causality.

General relativity maintains that there is no objective rational division of the continuum. Its equations are nonlinear, involving second derivatives, and are only solved approximately. As such, it lends itself to the calculus of variations, particularly the Lagrangian action (i.e. energy-time) density integral of matter, charge, and their respective fields.

The gravitational field, in fact, is self-generating, in the sense that its force acts on one of its sources, the matter/energy. And for this reason it cannot be “localized”, because it draws off both matter/energy and space-time, which interact mutually. Attempts to define an invariant for the matter/energy or the space-time thereby dead-end at a pseudotensor for the gravitational energy, nontransformable to other coordinate systems. Hence we have no rational relativistic model for the influence of gravity in the atomic realm.

Rather than an unbroken continuum, quantum mechanics speaks for a fundamental discreteness in the very texture of space-time. When Heisenberg presented the uncertainty principle in 1927, he noted that the concepts as then applied to particles and waves (e.g. velocity, frequency, amplitude, field strengths) were originally derived from everyday experience. He realized these ideas soon become inadequate when applied to atomic phenomena such as electrons. An inherent indeterminism accompanies any characterization of microcosmic entities and events, in which customary concepts reach their meaning’s limit. At best, we are only able to perceive the generalized effects of sequential measurements, as probabilities instead of certainties.

Heisenberg deduced the eloquent equations  $\Delta x \Delta p \geq h/2\pi$  and  $\Delta E \Delta t \geq h/2\pi$  that describe this predicament, Any use of the concepts “position” and “momentum”, or “energy” and “time”, are necessarily limited in accuracy. The most precise knowledge of either pair must not be smaller than Planck’s constant  $h$  ( $6.626 \times 10^{-34} \text{ m}^2 \text{ kg/sec}$ ) divided by  $2\pi$ , else these ideas become meaningless.

The imprecision and unapprehensibility arise from within the mystery of the matter/energy event itself. The electron does not possess position or velocity as an observable quality, but rather the property of “probability”- a specific likelihood of positional extent when linked with a given range of momenta. Its mass-energy content and the space-time it occupies are uncertain, within these probabilistic bounds. We may obtain only average values, for position or energy, by examining a collection of probabilities.

Uncertainty is intimately related to the finite time required for the emission of light, as though it were implanted in the photon at its conception. An atom sends out a light signal because radiation progresses in the direction of increasing entropy- the thermodynamically irreversible arrow of dissipation. About  $10^{-8}$  seconds is needed (or once every  $10^{14}$  nuclear oscillations) for photons, when created, to overcome the resistance from local fields and radiate away into space. This tenuous suspension of the light event, arising as the balance of matter and energy seeks havens of equilibrium against inevitable dissolution, is enough to generate the probabilistic ambiguity. It is as if, at our local world-point, the uncertainty principle expresses the essential relation between the time coordinate and space coordinates of space-time. It is a measure of their difference.

Curiously enough, when we combine the well-known result of special relativity ( $E=mc^2$ , which says that in an unaccelerated reference frame, the energy content of a body at rest is equal to its mass) with the result of uncertainty, we have the novel result that  $\Delta E = \Delta mc^2$  and therefore  $\Delta m \Delta t \geq h/2\pi c^2$ . This establishes a ratio between the two primary scientific constants  $h$  and  $c$ . Multiplying by the gravitational constant  $G$  ( $6.673 \times 10^{-11} \text{ m}^3 / \text{kgsec}^2$ ) gives us  $G/hc^2$ , which has the dimensions  $\text{m}^3 / \text{sec}$ . This fundamental measure of space-time would appropriately be designated as an “einstein”, just as a newton is a measure of force.

The new result  $\Delta m \Delta t \geq h/2\pi c^2$  has the value  $1.174 \times 10^{-51}$  kg-sec; it says that, for an unaccelerated reference frame, this is the ultimate limit we can attain in regards to how a body can change its energy-time content. This is a mathematical expression for the fundamental discreteness of the space-time web itself, as it applies for a body at rest. It is the extent, it is the span in other words, of each granule of space-time- which over lengths of time may be more appropriately characterized as filaments.

The quantum states of atomic physics are evidently 30 to 40 powers of 10 greater than the quantum structure of the underlying space-time. Their typical mathematical expression is found in the Hamiltonian- an energy matrix of probability amplitudes that modulate over time. Quantum mechanics is linear; the variables in its equations are reducible to the first or zeroth power. This enables superposition of states, for any time sought, by addition or multiplication.

As a description of physical reality, its Achilles' heel is that some arbitrary gauge- a basis for differentiating the energy matrix- must be chosen when partitioning the time or the space. And so it becomes a refined system of atomic sets, devoid of any considerations of gravity.

And yet still it has produced lasers, superconductors, semiconductors and microchips, and all of the technology of nuclear physics via a world description embracing probabilities, parity violation, virtual particles, anti-particles, strong & weak nuclear forces, atomic orbitals and structured sets of nuclear energy levels. General relativity, on the other hand, has given us curved space-time, time dilation, the redshift and the bending of light, the precession of planetary orbits, black holes and gravitational waves via a 4-dimensional system of partial differential equations, covariant and nonlinear, that describe the world in terms of everywhere-continuous fields.

These fields eventually become discontinuous, that is to say quantized, but only at the submicro level. There is no philosophical barrier preventing the gravitational field from affecting matter/energy at the micro level, meaning the familiar dimensions of atomic & nuclear physics.

## A FIELD EQUATION FOR ELECTROGRAVITATION

In order to make progress toward a unified field theory, it may become necessary to give up the idea that electrical charge is quantized. It might be so only in appearance, at distances greater than  $10^{-15}$  meters- somewhere outside the nucleus. Like Newton's gravity, Coulomb's law of electrostatics may eventually diverge from the inverse-square.

A careful distinction needs to be made between electromagnetism and charge. The charge density ( $Q_{tt}$ ), currently considered equal to the number of electrons in a unit volume, includes as well the residual forces (self-forces holding electrons together, and nonradiating atomic orbitals) which do not release radiation. Charge is a 4-dimensional pressure, and electromagnetic waves are one of its effects.

The field for concentrated charges remains a mystery, a century and a half after Maxwell's theory of electromagnetism. The electromagnetic field becomes infinite at an electron- a point particle with a point charge that has zero spatial extent. A related mathematical difficulty arises in the wave equation

$\nabla^2 \phi(r, t) - 1/c^2 \partial^2 \phi(r, t) / \partial t^2 = 0$  which tells us duplicitously that a spherical wave may emerge from a charge after it accelerates, or it may arrive at the charge before it ever moves.

A singularity carrying charge thus produces infinite energy, or alternatively, waves dually incoming and exiting. In the mathematics these difficulties are usually evaded by dealing with charged matter as a continuous distribution, to both evaluate the electromagnetic field and to confirm that the conservation of electromagnetism holds precisely, even in curved space-time. Yet for *uncharged* matter, conservation of energy is admittedly only approximate, since the gravitational field acts on matter, and itself has inherent energy. So that energy may “disappear” into the space-time web, reappearing “later”.

This enigma regarding charge is alluded to in the general field equation:

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} + 8\pi G T_{\mu\nu} = 0$$

[where  $R_{\mu\nu}$  is the fundamental curvature tensor of space-time,  $R$  is its scalar value, the  $g_{\mu\nu}$  are the 10 potentials that describe the gravitational field,  $G$  is the gravitational constant and  $T_{\mu\nu}$  is the energy tensor of matter, with the subscripts  $\mu, \nu$  ( $= t, x, y$  or  $z$ ) representing the 4-dimensional components of each tensor.]

Einstein states explicitly that the matter/energy tensor, which includes in itself the energy densities of the electromagnetic field and of ponderable matter, is not yet determined in its true form. This is due to the fact that the electromagnetic field, governed by Maxwell’s equations, is only understood “outside” charged particles, and not at their source, presumably as singularities.

If we dispense with the idea that charge is quantized- localized within point particles- we arrive at the same approximation as for uncharged matter, namely, that the conservation of electromagnetic energy for charged matter is only valid for regions greater than roughly  $10^{-15}$  meters, where Maxwell’s equations remain accurate. This is the critical region where protons attract one another and stabilize into matter. Beyond the micro level, this conservation principle may no longer hold.

The forces of charge and of gravity each act at light-speed, yet there is a fundamental paradox, apparently irreconcilable. Gravity is always only attractive, whereas charge both attracts and repels. If charged matter, similar to uncharged matter, is only approximately conserved, might not charge mirror gravity? In the sense that it might also be properly characterized as a tensor- a multilinear matrix of 4-vectors? We would then be able to incorporate it into Einstein's general field equation.

We have grounds for this characterization, from the landmark 1957 Lee-Yang-Wu analysis of radioactivity's beta-decay. They discovered that transitions involving the axial components violated the law of parity, aka spatial inversion. The emitted particles spun with a preferential "handedness", directly along the direction of flight, and the mirror image of this process simply did not happen. This is in point-blank disagreement with the conduct of gravity and electromagnetism, which are symmetric with respect to inversion. And as with other physical laws, symmetry implies conservation of energy. The weak force of nuclear physics, which has been attributed as responsible for beta-decay, apparently does not always abide by this conservation principle.

And so without the strict adherence to conservation laws, charge might provisionally be regarded as aligning with the continuum down to its submicro levels. The point of view chosen here is that charge does mirror gravity; charge produces electromagnetism, which interacts with gravity, which interacts with matter and the space-time web. Effectively, one force may transform into the other.

This perspective allows us to reinterpret Einstein's field equation, remaining faithful to its spirit. Let us decompose the matter/energy tensor  $T_{\mu\nu}$  into components  $Q_{\mu\nu}$  and  $T_{\mu\nu}$ , with  $Q_{\mu\nu}$  representing the tensor of charge (which may have a positive or a negative effect) and  $T_{\mu\nu}$  keeping what remains of the original  $T_{\mu\nu}$ , i.e. the energies of ponderable matter and of the electromagnetic field.

We further incorporate the constant  $h/2\pi c^2$  from our previous section, which outlined the correspondence between equivalence and uncertainty. This is justified, by all previous philosophical considerations, as expressing how charge “couples” to matter, or equally, gravity to charge.

We thereby define  $T_{\mu\nu} = (h/2\pi c^2) Q_{\mu\nu} T_{\mu\nu}$ .

We then arrive at:

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} + (4Gh/c^2) Q_{\mu\nu} T_{\mu\nu} = \kappa_{\mu\nu}$$

where  $\kappa_{\mu\nu}$  represents the electrogravitational field, presumed to exist. The multiplier  $4Gh/c^2$  has the value  $1.96775 \times 10^{-60}$  einsteins, in our new unit for the metric.

Electrogravitism is conceived as the mutual effect of the two forces, charge and gravity, which are postulated to transpose, one into the other, under certain special conditions. In this way they may be regarded as one force, which has their dual aspects. The  $\kappa_{\mu\nu}$  is a measure of the fields gravity plus ponderable matter of any charge, and these two sources interact, each with each other and the space-time continuum.

A local minimum may be assigned for the region near  $10^{-15}$  meters, where matter equilibrates. Here the forces of charge are counteracted to near exactness by gravitation, with the net result being a spherical equipotential surface- the proton.

## CONCLUSION

Not only have we examined a philosophical connection between the principles of equivalence and uncertainty, which lead to a heretofore unsuspected mathematical relation between quantum physics and special relativity. This is satisfying, taking into account that most of the experiments in nuclear physics apply the approximations of special relativity to give constancy to the inertial frames of the laboratory- use of a “flat” space-time metric that neglects considerations of gravity.

But also we have re-examined the essence of the concept of charge- whether this 4-dimensional pressure is quantized only in appearance. If it is instead more correctly described as a dualistic electromagnetic force aligned with the continuum, down to its submicro level, then it may be properly included as a component of the matter/energy tensor of general relativity.

As such, charge may then be regarded as another manifestation of an electrogravitational force which permeates the web of space-time. And its substantiation in the general field equation- with a possibility of transposing to gravity- raises the further possibility that localized accumulations of charge may effectively counteract gravity. Charge, under these special conditions, would need to be condensed to a greater degree than currently known.

The quantum vs. relativity debate will undoubtedly continue for many more years, but it is the opinion of this essay that Einstein’s general relativity has been abandoned prematurely by particle physics, that he may yet have the last word.

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