The Ephemeris
Focus and book reviews

# The Locally Induced Electric Field

The opinion that Maxwell's electrodynamics is a limited—rather than a fundamental—theory was repeatedly expressed during the last decades, notably by Wesley. Wesley's criticism was always directed against the Grassmann-Biot-Savart-Lorentz force law which violates Newton's Third Principle and is contradicted by experimental facts [1]. To this one might reply that present-day electrodynamics consists of three distinct parts [2]:

(a) Maxwell's field equations,
(b) The force acting upon moving charges and
(c) The constitutive relations $\mathbf{B} = \mathbf{B}(\mathbf{H})$, $\mathbf{D} = \mathbf{D}(\mathbf{E})$, and $\mathbf{j} = \mathbf{j}(\mathbf{E})$

so that the failure of (b) does not necessarily trigger a failure of (a). This argument is forcefully pushed forward by Post [3] who re-iterates the conclusion of Kottler, Cartan, and van Danzig that the field equations (a) written in terms of **E**, **B**, **D**, and **H** are generally covariant, while the specific symmetry—in particular the Lorentz symmetry—has to be relegated to the constitutive relations (c). Therefore, the field equations—so Post—do not preferentially single out the Lorentz transformations, except for the free space situation where $\mathbf{D} = e_o\mathbf{E}$ and $\mathbf{B} = m_o\mathbf{H}$. Due to the generally accepted isomorphism between Maxwell's field equations in vacuum and Einstein's "special" relativity from one hand and the covariance of the Lorentz force $\mathbf{F}_L = q(\mathbf{E} + \mathbf{v}\otimes\mathbf{B})$ under Lorentz transformations from the other hand, the failure of $\mathbf{F}_L$ is thought to imply the failure of the field equations, too. Although this syllogism is not necessarily true, the field equations are, nevertheless, contradicted by empirical facts. The stringent question today is: "Which field equation is empirically wrong?"

Independent of experimental facts, a hint was provided by Jammer and Stachel [4] who stated: "If one drops the Faraday induction term from Maxwell's equations, they become exactly Galilei invariant." Although, as demonstrated by Phipps [5], it is not necessary to drop the Faraday induction term, or any other, from Maxwell's vacuum electrodynamics in order to achieve exact Galileian *invariance*, there are today several reproducible macroscopic experiments where electrodynamic induction without **B** field and without Maxwell's "flux rule" have clearly been demonstrated. It is worth recalling that Maxwell's field equations are *local* differential equations with partial derivatives, derived from the *global* laws of Gauss, Ampère, and Faraday formulated for extended systems. No wonder that for closed current loop sources of the magnetic potential **A** so different laws as the Grassmann-Biot-Savart-Lorentz and of Ampère—one violating Newton's Third Principle, the latter obeying it—are equivalent in most situations. Actually, in Phipps' words, the two forces which differ only by exact differential quantities, are "loop equivalent." For such forces the "shape independence theorem" [6] holds. Anyway, since the experiments of Müller [7] have clearly demonstrated the *localized nature of induction*, it is not enough to account for the electromotive force (EMF) around a closed current loop; one needs also the potential difference induced in a finite portion of the loop. In other words, one needs the explicit expression of the *force of induction* $F_{ind}$ acting *locally* upon a charge q.

## 2. In Search of the Force of Induction

According to the presently prevailing view, the phenomenon of electromagnetic induction is encapsuled in Faraday's "flux law":

$$-EMF = \frac{d\Phi}{dt} \tag{1}$$

or, using standard notation:

$$\frac{1}{q}\oint d\mathbf{s}\mathbf{F}_{ind} = -\iint(\nabla\otimes\frac{d\mathbf{A}}{dt})\mathbf{n}d\mathbf{a} = -\oint d\mathbf{s}\frac{d\mathbf{A}}{dt} \qquad (2)$$

The identification of the integrands in Eq. (2) supplies the “loop definition”

$$\mathbf{F}_{ind} = -\frac{d\mathbf{A}}{dt} \qquad (3)$$

It can be shown that the same “flux rule” (1), for a rigid and static loop, expresses the induced electrical field $\mathbf{E}_{ind}$ as a combination of a scalar and a vector potential, respectively:

$$\mathbf{E}_{ind} = \frac{\mathbf{F}_{ind}}{q} = -\nabla\varphi - \frac{\partial\mathbf{A}}{\partial t} \qquad (4)$$

The term $\partial\mathbf{A}/\partial t$ is called “transformer field” (see Sec. 3).

Although $\nabla\varphi$ integrates to zero around a closed loop, (3) and (4) are equivalent only if one neglects the so-called *motional induction*, which accounts for the velocity of the conductor (containing the charge q) with respect to the source of **A** taken as a rigid unit. Maxwell’s electrodynamics, being unable to describe the form of motional induction, has silently introduced the oxymoron

$$\mathbf{E}_{ind} = -\frac{\partial\mathbf{A}}{\partial t} + \mathbf{v}\otimes\mathbf{B};(\mathbf{B}\equiv rot\mathbf{A}) \qquad (5)$$

which was required to explain the *Hall effect* and the *unipolar induction*. This “ad hoc” procedure was later picked up by Lorentz while completing Maxwell’s equations with “his” force, a combination of the forces of Coulomb and Grassmann-Biot-Savart. Anyhow, it is remarkable that already in 1845 F. Neumann has split the EMF into two parts, one given by the time-rate of change of **B** (or **A**) and the other by the motion of the conductors through **B**.

For Wesley [8], the “loop definition” (3) is an indication that $\mathbf{E}_{ind}$ has to include the *total* time derivative of **A** given by

$$\frac{d\mathbf{A}}{dt} = \frac{\partial\mathbf{A}}{\partial t} + (\mathbf{v}\bullet\nabla)\mathbf{A} \qquad (6)$$

Here **v** denotes the velocity field of the electron current in a conductor –seen as a moving fluid—and $\mathbf{A}(x,y,z,t)$ the vector field which it “sees.” In the absence of EM radiation, like in the context of EM induction, the descriptions *via* ´point charges´ and/or *via* continuous fields in space, are mathematically isomorphous. The fields do not decouple from their sources and achieve independence, like in the case of radiation.

It is not difficult (but not trivial, either) to see that for $\mathbf{v}\bullet\mathbf{A}$ = constant the identity

$$\nabla(\mathbf{v}\bullet\mathbf{A}) = (\mathbf{v}\bullet\nabla)\mathbf{A} + \mathbf{v}\otimes(\nabla\otimes\mathbf{A}) \qquad (7)$$

holds, thus making (3) and (5) identical!

It is hard to resist the temptation to define the locally induced electric field by exploiting the generally valid identity:

$$\nabla(\mathbf{v}\bullet\mathbf{A}) = (\mathbf{v}\bullet\nabla)\mathbf{A} + (\mathbf{A}\bullet\nabla)\mathbf{v} + \mathbf{v}\otimes\mathbf{B} + \mathbf{A}\otimes(\nabla\otimes\mathbf{v}) \qquad (8)$$

Thus:

$$\mathbf{E}_{ind} \equiv -\frac{\partial\mathbf{A}}{\partial t} + \mathbf{v}\otimes\mathbf{B} - \nabla(\mathbf{v}\bullet\mathbf{A}) + \mathbf{A}\otimes(\nabla\otimes\mathbf{v}) \qquad (9)$$

which includes (5) as a particular case. The equivalent form

$$\mathbf{E}_{ind} \equiv -\frac{\partial\mathbf{A}}{\partial t} - (\mathbf{v}\bullet\nabla)\mathbf{A} - (\mathbf{A}\bullet\nabla)\mathbf{v} \qquad (10)$$

includes the “flux rule” as a particular case.

## 3. Comments on Equation (9)

Many physicists and electrical engineers are still amazed that a soft-iron transformer—and even more so an autotransformer—works at all! Indeed, the magnetic field outside the magnetized iron-core –there where the secondary winding is—is negligibly small, the second winding therefore doesn't "cut magnetic force lines." "No line cutting—no induced EMF" they reason. Apparently they encounter difficulties in understanding that rot**A** (*i.e.*, **B**) can well vanish and nevertheless an EMF given by $-\partial\mathbf{A}/\partial t$ is induced.

Since Oliver Heaviside first wrote Maxwell's vectorial equations in terms of **E**, **B**, **D**, and **H**, thus "murdering the **A** field" more than a century ago, people became accustomed with the force-field—instead of the potential field—treatment of electrodynamical problems. No wonder that the Aharonov-Bohm (AB) effect came out of the blue. Since the quantum-mechanical Hamiltonian contained **A** only, rather than **B**, they eagerly interpreted the **AB** effect as a genuine quantum-mechanical phenomenon. However, *the* **AB** *effect is no more mysterious than the functioning of an iron-core transformer!* Wesley [1], and Angelo, Rodriguez, Spavieri [9] have shown that a "non-standard force" $-(\mathbf{v}\bullet\nabla)\mathbf{A}$ added to $\mathbf{F}_L = \mathbf{v}\otimes\mathbf{B}$ is able both to solve the energy paradox of Shockley and James and to explain the AB effect in classical terms of force-action. Their attempt to save Faraday's (and the "special" relativists') "flux law," the authors [9] have mingled gold with clay, since $\mathbf{E}_{ind}$ is given *either* by Eq. (9) *or* by Eq. (10); one cannot add $-(\mathbf{v}\bullet\nabla)\mathbf{A}$ to $\mathbf{F}_L$ even if $\nabla(\mathbf{v}\bullet\mathbf{A})$ integrates to zero around a closed loop. The correct statement is that *the force derived from the pseudopotential* $\mathbf{v}\bullet\mathbf{A}$ (which equals $(\mathbf{v}\bullet\nabla)\mathbf{A}$ if $\mathbf{v}$ = const. and rot $\mathbf{A} = 0$) *supplies the classical explanation of the AB effect*.

The late Stefan Marinov tried (in vain) for years to run his "Siberian Coliu" machine [10] as a "perpetuum mobile." This machine, christened "Marinov motor" by Wesley, just after the 1997 Cologne workshop *Physics as a Science* [Proceedings], works both as a motor and a generator and is a machine working under the conditions $\partial\mathbf{A}/\partial t = 0$; $\nabla\bullet\mathbf{A} = 0$; $\mathbf{B} \equiv \text{rot } \mathbf{A} = 0$. It defies, therefore, any explanation within the frame of the presently accepted Maxwell-Lorentz electrodynamics. As shown by Wesley, the *net torque* driving the ring rotor (or, alternatively the suspended "Siberian Coliu" magnet) is provided by the force $-q(\mathbf{v}\bullet\nabla)\mathbf{A}$.

To complete the present list of electrodynamic effects without **B** field, we shall briefly comment on the observed interaction between two toroidal magnets. Since the magnets are electrically neutral and—except for neglibibly weak stray fields—the **B** field is confined within the interior of the tori, there are no electrical and no magnetc exterior fields that could provide a force between two tori whatsoever. Moreover, the vector potential does not have any explicit dependence on time, i.e, we have $\partial\mathbf{A}/\partial t = 0$. Tom Phipps [11] took over the idea of the **V**irtual **A**mpère **C**urrent **E**lement (VACE) from Reginald I. Gray and performed experiments with the purpose to "resolve the eternal stand-off between Lorentz's and Ampère's laws of interaction between current elements." A VACE is a toroid of permanent magnetic material, entirely enclosing a (closed) magnetic flux. He used two commercial horseshoe Alnico magnets, thus approximately realizing the equivalent of a short "virtual current" element normal to the plane of the ring. He succeeded to measure the force between two rings (one resting on top of a sensitive electrobalance) and to *confirm the prediction of the Ampère law for the dependence on the angle* $\alpha$ *between the planes of the tori*. The dependence on the separation distance r between the centers of the tori turned out to be much stronger than inverse square $1/r^2$. We point out that the concept of VACE is a *virtual* one, since a real motion of either charges or of current elements is by no means granted. In order to solve this riddle, Wesley suggested to replace the permanent magnet rings by two toroidal solenoids, so that each of them could be wound with equal numbers of turns advancing around the ring in opposite directions, the solenoids therefore not yielding any net current around the rings. He claims that the existence of *real* currents in the solenoids were able to supply the acceleration (of charges) needed to account for non-radiating, motional induction effects, as implied by the term $-(\mathbf{A}\bullet\nabla)\mathbf{v}$ in Eq. (10). Another possibility would be to trace the origin of the force between the solenoids back to the term $\mathbf{A}\otimes(\nabla\otimes\mathbf{v})$ in Eq. (9). Only quantitative experiments will decide between the alternatives. Finally, one has to keep in mind the *electromotive* nature of the motional induction forces, so that the conduction electrons within the solenoids have to transfer–via inelastic collision processes—their energy to the ionic lattice of the metallic conductors, thus explaining the *ponderomotive* force acting between the solenoids.

The exciting story of the recent developments in electrodynamics has brought us far from the cherished Maxwell-Lorentz theory—so vehemently defended by the “special” (very “special,” indeed!) relativists. Before closing, we draw attention to the pioneering works of Smith and Purcell [12], and, more recently, of Kim [13] who have convincingly shown that “the net energy transfer from the beam electrons to a laser field is possible only when there is a DC force five orders of magnitude larger than the force of Lorentz,” thus explaining why the classical electrodynamics cannot account for the net energy transfer in a free-electron-laser.

An intriguing question is the unexplained transition from *total* to *partial time derivative* in the transition from the integral form of Faraday´s flux-rule (1) to its traditional differential form with *partial* time derivative of **B** in the right side . *This question deserves a separate investigation.* It turns out that *Maxwell´s field equations in vacuum are Lorentz covariant only if all space and time derivatives are partial and—so to say— on equal footing! The total time derivative in Faraday´s flux rule would destroy the “spacetime symmetry” of the electromagnetic field equations.*

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## The Bookshelf

*Spiral Grain of the Universe : In Search of the Archimedes File* by Vladimir B. Ginzburg, Paperback (December 1, 1996) Helicola Press, IRMC, Inc.; ISBN: 1560026650 $9.95

*Before the Big Bang : The Origins of the Universe* by Ernest J. Sternglass Hardcover - 256 pages (November 1997) Four Walls Eight Windows; ISBN: 1568580878 $24.95

# If There Is No Thomas Precession, What Then? (“Light-signal” Versus “Intrinsic” Relativity)

*“Whence cometh the energy of the Thomas precession, which by definition is of purely kinematic origin, all torques and physical energy sources being absent?”*

—T.E. Phipps, 1986.

As we come to the end of the 20th century, it seems an appropriate time for some unbiased outsider, with a good knowledge of science in general, to review the long-term progress of modern astronomy and physics. The aim of such a review would not be to list all the recent progress which may have been made, for example through use of the Hubble telescope or powerful particle accelerators; but rather to ask whether any workers in those fields may have come to accept, through intensive higher education or peer pressure, certain doubtful assumptions which will only impede their progress in the future. Quite interestingly, an English sociologist has reviewed particle physics in that way, and has produced much controversy (A. Pickering, *Constructing Quarks*, 1984; *Nature* 387, 543, 1997).

### Only a Few People Make All the Decisions

No distinguished astronomer or physicist today is likely to announce that some important assumption in his field may be wrong, or else he would lose all intellectual status and very likely his career. Thus, this task falls to the well-informed generalist, who can say things purely on the basis of scientific merit, as did T.H. Huxley in the 19th century.

My first introduction to modern astronomy was by correspondence with H.C. Arp, who assured me that ruling paradigms were arrived at mainly by academic politics, rather than logical choice among competing theories. I soon found out that he was right, when I attended the yearly astronomy meeting here in Australia, where nearly all workers were adherents of the Big Bang (or all who spoke publicly). No discussion of any other model was allowed, say of the “tired light” or “variable mass” hypotheses for extragalactic redshifts. Even today, little mention is made of Arp’s work or his new book *Seeing Red* (Apeiron, 1998) in academic journals, as a possible solution to the “dark matter” problem.

My first introduction to modern physics was by conversation with an Australian physicist Peter Tulloch, who did his thesis on “gravity as a particle,” rather than “curved spacetime,” and who died recently of stress-related illness at age 50. Peter sent off his work for publication, only to have it rejected by a famous Cambridge cosmologist: not on the grounds of incorrect math or disagreement with experiment, but as “bad philosophy.” Peter assured me that modern physics was a “closed shop,” where only a few people in power took it upon themselves to decide the interpretation of any experiment for the unwashed masses; and no input from any outside source would be allowed.

But it was done that way 500 years ago in the Middle Ages! See the book *Galileo’s Daughter* (1999) by Dava Sobel, which explains how the Aristotelian academics were offended by Galileo’s emphasis on experiment rather than authority, and how he made interpretations of experiments without official approval. Hence everything they were teaching in the schools was implied to be wrong, because one little man was causing trouble.

Now we wish to examine today, whether any residue of that backward, authoritarian thinking persists in our modern, intellectually-free age. One might look at many different fields of knowledge to make such an examination: for example brain research, Darwinian evolution, psychotherapy, or modern medicine. But for brevity, we will limit ourselves to modern astronomy and physics, because the current practitioners of those fields seem to believe that they “know so much they can’t be wrong.” One may wish to investigate whether that is really so?

Over the past 10 years, I have found that most of the observations made by Arp or Tulloch are generally true. Thus, one possible theory out of many is often selected hastily by a few powerful astronomers or physicists for further development, which results quickly in a “tidal wave of elaboration” by lesser lights in the field. Hence, much vested interest is soon placed in some poorly-chosen theory, which greatly impedes further progress if that initial theory turns out to be wrong. This is just as John Locke wrote in 1690: "If those that pass for principles are not certain, but are only made so to us by our blind assent, we are liable to be misled by them and, instead of being guided into truth, we shall by principles only be confirmed in mistake and error."

As an outsider to the fields of astronomy and physics, but with good experimental knowledge of both, I have noticed over many years that certain major, well-accepted theories within those fields do not seem to adhere very closely to known experimental data. Perhaps more data need to be collected, or perhaps the theories themselves need to be revised? Since only a few people of little power seem concerned with such difficulties, it may be worthwhile to bring them to the broader attention of workers and students worldwide. Then everyone may study those problems more closely, and not just yield their complete will through "blind assent."

### Ten Topics for Further Discussion

(1) First, there seems to be an obvious need to revise our understanding of special relativity, because its predictions concerning mass and time (in a non-reciprocal sense) come out okay, but its predictions concerning length or Thomas precession do not. Hermann Bondi wrote in his introduction to *Space, Time and Gravitation* (1986) that length contraction cannot actually be observed, although it happens just as special relativity predicts. Well, that is one way by which a theorist can escape from confronting experiment.

Still, a direct and measurable consequence of any length contraction would be the well-known Thomas precession (L.H. Thomas, *Nature 117*, 514, 1926), where an electron in orbit about a proton is said to go slightly backward in a reverse fashion from where it should be, due to length contraction of its circular orbit as seen by the proton at rest. The most rigorous derivation of Thomas precession was given by W. Furry (*American J. Physics 23*, 517-525, 1955), who showed that it follows from length contraction combined with space rotation, where successive small segments of a "polygon" contract in length individually, then join to one another by slight rotation end-to-end. The use of a "polygon" rather than a "smooth circle" to derive Thomas precession is just a mathematical fiction, made necessary because special relativity cannot deal with accelerated systems. In any case, length contraction is treated in special relativity as "strain without rotation," while Thomas precession is treated as "strain with rotation."

The critical point here is that Thomas precession follows from a series of hypothetical length-contractions in space, so that it should be directly measurable; while "corrections to time do not come into the calculation" (Furry, 1955). Nor does any "composition of velocities" enter into it, as an effect of higher order. Furthermore, since special relativity is supposed to be scale-invariant, not only tiny atoms but also macroscopic spinning disks (the size of old LP records) should go backwards by Thomas precession; likewise on a much larger scale, huge planets should go backwards in their orbits about a star, relative to their expected positions by Newtonian gravity.

Yet to my knowledge, *none* of those three predicted length-contractions in atoms, laboratory disks, or planetary orbits actually occurs. What is going on here? Could special relativity, as the mainstay of 20$^{th}$ century physics, be wrong in such a fundamental way? A few discussions with T. Phipps and G. Galeczki (*Apeiron* 3, 120, 1996) suggest the following scenario.

(2) In textbook models for atomic spectroscopy, the Thomas factor is always added as a "fudge," to make a simple spin-orbit coupling give the correct magnetism for hydrogen; otherwise the quantum-mechanical derivation comes out wrong by a factor of two. But nowhere does a Thomas factor enter the Dirac equation or the experimental Sommerfield expression, where the magnetism of any $s$, $p$, $d$, $f$ orbit varies by a factor of $n/l$. Here $n$ = the quantum shell or number of deBroglie waves, and $l$ = 1, 2, 3, *etc.* relative to an open-circular path. Hence only a fraction 1/1, 1/2, 1/3, *etc.* of any electron path actually generates magnetism. I argue elsewhere that such behavior is consistent with vector addition of angular momentum, within various four-dimensional topological isomers, for wrapping of an electron about a proton in both space and time (along the views of David Bohm).

By that view, the electron may adhere to a well-defined topology in every orbit, although its geometrical path will be only probabilistically defined, upon projection into *xyz*. Such well-defined topology would explain why we see sharp spectral lines in an atomic spectrum; that energetic stability could not easily arise from the electron as a diffuse, ill-defined "cloud." The emphasis should be on *experiment*: which possible models for the electron will generate magnetic energies equal to $n/l$ as observed?

Let us now recall what is taught by quantum theorists in the schools. Those theorists first insist that the electron can have no well-defined path or velocity, because of the Uncertainty Principle which forbids such measurement (by current methods). Then they apply a hypothetical Thomas precession from special relativity, to make their "cloud-like" calculation fit spectral data on atomic magnetism. In particular, they argue that a Thomas precession will reduce the magnetic energy of any electron by a factor of two (as half of the forward Larmor precession), because a series of differential length-contractions will make the electron orbit less frequently about the proton, thereby giving less angular momentum and less magnetism.

Yet the value of any Thomas precession would depend critically on both electron path and velocity, neither of which according to those theorists can be defined! Essentially they are mixing apples and oranges, to use a hypothetical length-contraction from special relativity in a purely probabilistic quantum theory, which admits no well-defined spatial position. In other words, the definition of $(x,y,z,t)$ coordinates should become probabilistic by ordinary quantum theory on a very small scale, so that a coordinate-definite scheme from special relativity cannot be applied. Still, such material has been taught in the schools for over 70 years: why have so few questioned it?

(3) Next, on the scale of an LP record, T. Phipps has carried out a nice experiment to test for Thomas precession, and thereby has shown that reverse precession of a spinning disk does *not* occur (*Lettere al Nuovo Cimento* 9, 467-470, 1974, or his book *Heretical Verities*, 1986, pp. 265-273). By all means, if academic physicists wish to reproduce that negative result, let them do so without delay, using materials of various deformabilities.

(4) Cyclotron experiments have shown a slight forward precession of the electron, for fast circular motion in a magnetic field, which varies in proportion to the extra part 0.00116 of electron magnetism (D. Newman *et al.*, *Phys. Rev. Lett.* 40, 1355-1358, 1978). This effect does not depend on relativity, since the same fraction 0.00116 (when multiplied by $eB/mc$) is found for both very fast and very slow electrons, at speeds of $0.5c$ or close to zero. The relativistic invariance of electromagnetic energies is thereby confirmed.

Yet those authors go one step further, and argue that their data represent "the most accurate test of Thomas precession to date." How can they deduce anything about Thomas precession from a null result? Do they see any electron moving backward from where it should be? No, they argue indirectly as follows: since the gain of energy due to mass-increase $m'/m$ of an orbiting electron seems to cancel precisely its loss of energy due to length-contraction $l'/l$ of the orbit (by Thomas precession), then the number 0.00116 will remain the same for any velocity which might be chosen, due to a precise cancellation of *mass and length*.

But is that a unique interpretation? An alternative view might be as follows: when any electron moves in a fast orbit, it actually undergoes changes in both *mass and time*, which then cancel one another precisely. In other words, the moving electron becomes more massive so as to absorb light of higher frequency, yet it counts time more slowly so as to absorb light of lower frequency. Because $m'/m = t/t'$, the two effects cancel and electromagnetic energy is conserved.

Now what would happen if we were to add, to those two effects in mass and time, a third effect due to length? The whole concept of invariance would be thrown out of balance! How can anyone obtain electromagnetic invariance for an *odd* number of relations in mass, time and length? In other words, $(1 - 1) = 0$ but $(1 - 1 + 1)$ cannot equal 0. Since we are sure that changes in mass and time actually do occur, whereas we cannot see changes in length, I believe we should forgo the hasty interpretation by Newman *et* *al.* (1978) in terms of mass and length, in favor of a more plausible interpretation in terms of mass and time.

For electrons in atoms, one hardly needs to worry about such complications, because electric and magnetic energies will remain invariant (since changes in mass and time cancel). All we have to worry about is finding a suitable model to explain the magnetic energies *n/l*, and not any length-contraction or Thomas precession. The Dirac equation does give those energies correctly, yet as noted by Furry (1955), it "provides no physical picture of the way the effect is produced."

(5) Now on a much larger astronomical scale, it appears obvious from modern orbital data on planets and pulsars, that those objects do *not* go backwards in their orbits as predicted by the length contraction-Thomas precession of special relativity. They actually show a slight forward precession, owing to increased motional gravity as per general relativity, which is analogous to magnetism as a motional form of electricity. Nowhere is length contraction seen for such clearly observable objects. Whether general relativity is just a useful calculating tool, or whether there really exists a "curved spacetime," remains open to question.

(6) Apart from the absence of length contraction, there seems to be yet another potential problem with special relativity, in that stationary astronomical objects all across the Universe are assumed to count time identically, and hence emit or absorb light of identical frequency. That untested assumption leads to the "dark matter" postulate of modern cosmology, so that astronomers may retain an interpretation of altered light-frequencies as Doppler shifts. But as H.C. Arp, F. Hoyle and others have noted, the assumption of precisely-constant time seems doubtful on a scale of galaxies. Also, recent measurements of time-dilation for supernovae in distant galaxies, show a dramatically different time-dilation than expected for any Doppler shift, when the Hubble redshift is interpreted as receding velocity from Earth. Thus they find $f'/f = t/t'$, without any $(1 - v/c)$ due to momentum as for a Doppler shift (*Apeiron 4*, 26-32, 1997).

In summary, from a careful study of all these experimental data, one may conclude that the length-contraction aspect of special relativity does not really occur. And if length contraction is wrong, might Lorentz covariance be wrong as well?

(7) Recall that Lorentz in 1894 argued that perceptions of length and time should vary reciprocally (or "co-vary") between two observers in relative motion to one another. He adopted this view, in order to show that "electromagnetic actions are entirely independent of the motion of the system." In other words, he believed that two observers in relative motion would each see the same electromagnetic energies at the same signal-speed $c$, accompanied by a reciprocal distortion in their perceptions of length $x$ and time $t$. He was driven to such a theory, one would guess, by the nature of inductive phenomena in electromagnetism, where only the *relative motion* of two charged particles determines their energies of interaction.

Einstein in 1905 then went one step further, and argued that "there is an inseparable connection between time and signal velocity." In other words, he extended the Lorentz model from a theory of *distorted perception* (by means of light images), to a theory of *distorted space and time* (where rods actually contract, and clocks count time more slowly). Indeed, he argued in 1911 that "the Lorentz contraction can as a matter of principle be demonstrated to a resting observer."

In order to understand such reasoning, let us consider an observer who rides along with a light wave at speed $v = c$. That fast-moving observer will never lie any significant distance from the light, so that $x' = 0$ as seen by a stationary observer elsewhere. Nor will he lie any significant time from the light, so that $t' = 0$ as seen by a stationary observer elsewhere. Hence by that model, both length and time are defined in terms of light-speed $c$, which remains constant in any frame of reference.

Most people would agree that changes in perception of the kind envisaged by Lorentz actually occur. For example, in modern astronomy there is the phenomenon of "superluminal expansion," where some star within our galaxy may eject luminous material very rapidly in the direction of Earth. We then perceive the velocity of such a jet as somewhat faster than $c$, because the luminous material travels very much closer to us as time passes. More generally, if the mass-time axes of two charged particles are tilted with respect to one another in four dimensions (by relative motion), then each particle may see the other count time more slowly and contract in size, for any light-images which are exchanged between the two.

But here is the catch: almost all modern measurements of altered mass $m$ or time $t$ are made directly, *without the use of light*! Thus the signal-velocity $c$ becomes irrelevant as a means of defining mass, length or time, and we will have to look for some other mechanism whereby a limiting speed of $c$ might be obtained. For example, it has been shown that muons with a lifetime of 2 microseconds at rest will adopt a greatly increased lifetime of 30 microseconds, when they are accelerated at close to speed $c$ in a cyclotron. One can measure the time-dilation of such muons directly, by point-blank detection of the electrons emitted when those muons decay; light-signals do not enter into it (J. Bailey *et al.*, *Nature 268*, 301-305, 1977). Nor do fast-moving clocks in Earth orbit require light-signals to count time more slowly (J. Hafele and R. Keating, *Science* 177, 166-170, 1972).

Nor have advocates of special relativity ever produced a single bit of evidence, to show that changes in mass or time when measured directly (without light), vary reciprocally to any two observers. For example, in the cyclotron experiment just mentioned, one would like to know how those fast-moving, time-dilated muons see the laboratory frame at rest. Do they see radioactive atoms from the laboratory count time 15 times more slowly, or 15 times more rapidly than normal? Conceivably one could design an experiment along those lines, but it has never been done.

The possible extension of Lorentz covariance from a theory of perception (by means of light) to one of distorted space and time, therefore hangs heavily on measurement of a Thomas precession, as our only evidence that length contraction might really occur: without length contraction, there can be no Lorentz covariance. But we showed above that the Thomas precession probably does not exist in real space and time. Hence the lengths of moving objects *do not contract* as seen by two observers in relative motion, at least when measured directly without the use of light. Still, mass and time seem to be altered by direct measurement as noted above. What could be going on here?

From careful study of experiment, we are led to suggest a second kind of relativity, not based on light signals, where mass and time may change in a direct intrinsic fashion for objects moving through some reference vacuum, while length does not change at all. The observed changes are just $m'/m = t/t'$, which yield a constant spin angular momentum and net invariance of electromagnetism, even on a very small scale. This second kind of relativity follows quite naturally in the absence of light, if the limiting particle-speed equals $c$, because any change of mass with velocity must be accompanied by an equal but opposite change of time, so that spin angular momentum will remain conserved.

But how might mass and time change with $v/c$ in this new theory as compared with the old? The equations will remain the same, although the interpretations will become very different. Thus, one can make an accurate geometrical analogue of "light-signal relativity," where relative velocity $v/c = \sin q$ and $q = 90^o$ for speed $c$. Such a geometrical approach will not work, however, for "intrinsic relativity," because changes of mass and time will not be seen reciprocally by two observers, nor will there be any change of length. A different condition may therefore be suggested for the intrinsic case as $ve^2 + vi^2 = c^2$, where $ve$ is the external speed of any particle, and $vi$ is its internal speed (as some kind of regular motion) for particles of finite but constant size. The reduced internal speed $vi$ for any particle in motion will reduce its rate of counting time; while the vector sum of $ve$ and $vi$ will always remain equal to $c$, as seen by an external vacuum at rest.

In summary, we feel that the experimental data describe *two different kinds of physical phenomena*: first, "light signal measurements" describe a distortion in the perceptions of length $x$ and time $t$, for light passed between any two observers in fast relative motion; second, "intrinsic measurements" describe a distortion in the dynamics of mass $m$ and time $t$, for fast motion of any single particle through a reference vacuum (*e.g.*, D. McCarthy, *Apeiron 5*, 104-106, 1998). Thus, the theory of Lorentz covariance should be restricted solely to cases of light signal measurement, for which it was originally derived; and not be extended any further to cases of intrinsic measurement, which do not involve light. Various experimental results support this view: (a) no Thomas precession or length contraction can be seen in the absence of light; (b) distortions of mass and time can be seen in the absence of light, but need not vary reciprocally; and (c) electromagnetic invariance by intrinsic measurement depends on there being just two variables (mass and time), rather than three (mass, time and length) which cannot all cancel by odd parity.

All of the so-called paradoxes of special relativity: for example the Ehrenfest paradox concerning length, the twin paradox concerning time, or the entanglement paradox concerning spin, follow from confusion over these two kinds of phenomena. For example, time may be dilated reciprocally for perception by light signals; but if one twin goes on a long space journey while the other stays home, only the fast-moving twin will be time-dilated intrinsically. Two different domains of measurement are essential in many fields: laminar versus turbulent flow in hydrodynamics, sieving versus deforming motion in electrophoresis, or intrinsic versus induced curvature in DNA. Profound confusion would follow if we did not distinguish the boundaries of any theory, and apply the correct theory to any given experiment.

To conclude, let us imagine that we were to ride along with an unstable muon at speed $v = c$. We know from experiment that such a muon would gain mass and count time more slowly; yet all a stationary observer elsewhere could see, is fewer than normal electron decay-events as a function of time. He could not measure length $x'$ of the muon by its distance from any light-wave, nor could he measure time $t'$ of the muon by its time-interval from any light wave. He can only measure time $t'$ of the muon by a unidirectional flow of electrons from source to observer. Hence, we see that these particle measurements are intrinsically asymmetric in both space and time, so that Lorentz covariance cannot be applied.

What would happen if Einstein were re-incarnated today, and wished to update his work in the light of improved data? Would the academic professors stand in his way? My impression is yes, they would definitely block a "new Einstein," which is why we have not seen one. (One is reminded here of John the Baptist, who was supposedly the re-incarnation of Elijah.)

(8) In addition to numerous problems with special relativity, the modern theory of particle structure in terms of "dimensionless points" seems quite doubtful. Such an assumption follows historically from Coulomb's Law on a macroscopic scale, where the electric charges $e$ are regarded as "points"; and also from the light-signal theory of length contraction, which seems to forbid any finite objects. But those point-like models lead to false infinities of energy on a microscopic scale, if normal electric charges are assumed to interact within a very tiny space. The infinities of energy which are so generated must then be removed by a fudge-procedure known as "renormalization," in order to calculate a finite experimental quantity such as 1.00116 for electron magnetic moment. There do exist alternative models for particles which agree well with experimental data, and contain only finite sizes and energies. But none of those are currently being considered by professional physicists, who believe that Lorentz covariance combined with renormalization are the essential attributes of any successful theory (P. Milonni, *The Quantum Vacuum*, 1994); rather than being artifacts of an incorrect model, caused by applying light-signal relativity to real particles, outside of its intended domain.

The particle physicists also throw in, like a "rabbit out of a hat," a purely empirical number 1/137.036 for the fraction of any electron which emits or absorbs light, so that their point-like particles may behave in a finite fashion in other circumstances. Can that small fraction 1/137.036 represent anything but virtual exchange within a electron of finite size, where a small part of its mass-energy becomes mobile and loosely-bound, and therefore available to the outside world as electricity? (One can show that the mobile part is just 1/128 to first order, subsequently modified by higher-order terms.)

(9) What other evidence might exist for the point-like nature of subatomic particles? High-energy scattering data indicate point-like constituents within a proton, and a point-like nature of the electron on a very small scale. But those scattering data do *not* indicate infinities of energy (or how could such scattering be finite?), nor do they address the possibility that any particle might contain several different levels of structure on successively-larger scales. By analogy, a DNA molecule in biology may be point-like at the level of a nucleotide, slightly larger at the level of a double helix, or much larger as a chromosome. One physi-

cal technique may measure the smallest level of structure, while another technique may measure the largest. If subatomic particles are continuous through time, then high-energy scattering over a short time may measure a point-like spatial dimension, whereas low-energy scattering over a long time may measure a large spatial dimension (as seen by diffraction).

(10) In astronomy, the mainstream cosmologists have recently obtained great popular acclaim, by extrapolating a dimensionless-point model all the way to the beginning of the whole universe. They have thereby converted a possible Expanding Universe to a doubtful Big Bang. It is a sign of our times that students are taught the Big Bang in schools, even at a very young age, as if it were established fact. Other astronomers, for example Arp, believe that galaxies eject quasars to "reproduce." Why else should we see compact x-ray sources as quasars around Seyfert galaxies? Is this a view to be scorned, that the whole Universe may be slowly growing and evolving over time? Do we all have to be creationists?

## Conclusions and Prospects

To conclude, these ten topics stand out as some of the most important places for further discussion in modern physics and astronomy. In my view, the only way to resolve such problems would be to adopt a second, intrinsic version of special relativity, that includes changes in mass and time but *not length*, with regard to the dynamic changes within any moving particle. Then there will no longer be any need for dimensionless point-particles, because their sizes will not contract on fast motion. Subsequently, one can derive from experiment various structural models of *finite size and energy* for all subatomic particles, beginning with the electron.

By this intrinsic version of special relativity, spin angular momentum would still remain conserved with fast motion, in order to preserve a relativistic invariance for electromagnetism. Such conservation would be possible, if mass and time vary inversely to one another within tiny particles of constant size on a very small scale; just as mass and time vary inversely for electron orbits in atoms, without any length contraction or Thomas precession. The electrical self-energies of particles would remain finite, owing to their finite size, which might also remove the need for renormalization. This would improve greatly the consistency of relativity with quantum theory, because it would remove most of the false infinities from QED. Newton's G might also be considered as a tiny self-energy of spin 2 within any particle of finite size.

Hardly any mainstream physicists are working along those lines, because they believe that their current models are satisfactory and need no revision. They *do not distinguish* between a relativity based on light signals, and a relativity based on the intrinsic changes of mass and time within any moving particle. Indeed, a search for "Thomas precession, relativity" on the WWW reveals hundreds of sites devoted to a mathematical elaboration of light-signal relativity, but none which address the logical distinction between light-signal versus intrinsic theories.

Put simply, those workers can calculate but they cannot think, conceptually in terms of competing logical frameworks. Nor have they read the relevant work of others, which places a great emphasis on "appearance versus reality." One can see by simple inspection that the equations of Lorentz and Einstein refer to light signals rather than to ponderable things; yet as noted by E. Kapuscik, the distinction between light-signal and intrinsic relativity seems not to have been considered before in the 20$^{th}$ century.

Many alternative physicists have argued that the electron may be a three-dimensional spiral through time. Personally I am tolerant of such views, but favor a four-dimensional double-spiral (as developed elsewhere) which gives a better fit to experiment. From that four-dimensional model, one can calculate many important physical quantities to high accuracy without renormalization: for example the electron magnetic moment to 1.0011596522, the first-order Lamb shift, or the fine-structure constant to 137.035993 (beyond current experiment). It hardly matters which model you choose, so long as the self-energies and electrical energies remain finite, and it shows good accord with experiment. Particles of higher mass may be studied as well, although their structures are more difficult to understand at the present time.

Hardly any mainstream astronomers are currently considering alternatives to the Big Bang, or alternative interpretations of altered light-frequency. Few indeed have read Arp's book *Seeing Red*, or articles by Hoyle and Narlikar (*Nature* 233, 41-44, 1971; *Astrophysical J.* 405, 51-56, 1993) on an evolving mass-field. Those astronomers have never stopped to question whether their underlying assumptions might be wrong, but instead have put all their eggs into one basket in the form of Big Bang cosmology. I find this rather depressing, and fear that true progress in astronomy will not occur for another 20 to 40 years.

Today's physicists and astronomers may not wish to read the arguments presented here, yet as G. Orwell wrote (Preface to *Animal Farm*, 1943): "If liberty means anything at all, it means the right to tell people what they do not want to hear." By all means, let those scholarly gentlemen refute such criticisms, by reference to experiment if they can. Or even better, let them begin the difficult task of revising their long-held views, as experiment tells them.

### Is There Any Thomas Precession in General Relativity?

As this essay goes to press, NASA is preparing to launch a gyroscope experiment designed to test the predictions of general relativity, especially geodetic precession and the Lense-Thirring effect (R. Forward, *Proceedings of the IRE* 49, 892-904, 1961). The Lense-Thirring effect is tiny, and describes a possible influence of the Earth's rotation on local gravity. Yet geodetic precession is large, and arises supposedly from the "curvature of space" about any massive body. More precisely, geodetic precession comes from a slightly increased energy of gravity for objects in motion, as $(1 + v^2/c^2)$ that of gravity at rest (cf. curvature of light around the Sun). That extra inward acceleration, as a second derivative of the distance travelled, then causes any orbit to curve inward more sharply in the direction of motion; and thereby produces a forward precession of any ellipse by $(1 + 3v^2/c^2)$ (cf. the elliptical orbit of Mercury).

A scientific review of this new gyroscope project (www.nas.edu/ssb/gpbch2.html) discusses the relation between Lorentz "invariance" (not covariance) and motional gravity. It concludes that Thomas precession will reduce the observed geodetic precession "by one-quarter, instead of by one-half as for electricity in atoms." But can Thomas precession really be a part of general relativity? If so, why does length contraction not influence the angle by which light bends around the Sun, or other gravitational phenomena? If those gyroscopes measure precisely $3v^2/c^2$ for geodetic precession, will that mean that they felt a force due to Thomas precession? Or might the entire calculation be hopelessly confused, just as when an imaginary Thomas precession is used to obtain fine-structure spectra in atoms?

More plausibly, let us imagine that relativistic changes to mass $m$ and time $t$ for orbiting objects in a gravity field might cancel, without there being any changes to length $x$ or Thomas (as a "light signal" effect and not "intrinsic"). Then gravitational energies would become truly invariant to relative motion, as for electromagnetic energies described above; since three parameters $m$, $t$ and $x$ cannot all cancel due to odd parity, whereas two can. A simple cancellation of mass and time would also prevent any "runaway" of gravitational energies to infinity, since an uncompensated increase in mass $m$ would lead to increased gravitational attraction, thereby producing increased $v/c$ and further increases in mass $m$ by an endless cycle. Instead, we see that gravitational energies increase with motion only by a finite amount as $(1 + v^2/c^2)$, just as for magnetism as a motional form of electricity; and without any runaway due to increased mass from special relativity. If gravity were really Lorentz covariant, and included three separate changes of $m$, $t$ and $x$, that would not be the case.

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