RETHINKING GEOMETRY AND EXPERIENCE

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ABSTRACT: According to H. Poincaré, only the purport of physical laws (P) and the geometry (G) combined as a whole can describe nature (N). Equally well, the expression (N)=(G)+(P) symbolically describes the paradigm. Using the premise *a universe as a whole cannot change its finite energy content,* this essay questions the contemporary scientific paradigm by investigating the 19th century assumptions that defined (P) that have affected the 20th century choice of (G).

1 INTRODUCTION

> *The first thing to say is how bleak the present situation is. In foundational studies of mathematics and physics we have been stuck for seventy years; despite numerous books, articles, and meetings, there has been no real progress.* Edward Nelson [9] (2002)

Ten years later, these words remain true. Have we reached the limit of our explanation power? Historically, major advances in science is marked by revolutionary shifts in paradigm; normal development is by incremental additions to the prevailing view of things.

The revolutionary shifts in thinking habits usually evoke extensive debate; examples of noteworthy events were: The publishing of: Copernicus' *De revolutionibus orbium coelestium*, Darwin's *On the Origin of Species* and Einstein's special and general relativity theories. Whereas, the numerous incremental additions are usually accepted without controversy.

Using mathematical symbolism, the physicist paradigm (N) is quantified by the expression $(N) = (G) + (P)$, the idea is Poincaré's, as described by Einstein [3] (1921):

> *Geometry* (G) *predicates nothing about the relations of real things, but only geometry together with the purport* (P) *of physical laws can do so. Using symbols, we may say that only the sum of* $(G) + (P)$ *is subject to the control of experience.*

The classical, end of 19th century, paradigm is defined by $(N_{19}) = (G_{19}) + (P_{19})$. The contemporary way of thinking, being the same as at the end of the 20th century, is quantified by $(N_{20}) = (G_{20}) + (P_{19}-) + (P_n)$ or $(N_{20}) = (G_{20}) + (P_{20})$. The three-dimensional cartesian geometry (G_{19}) is replaced by the space-time continuum (G_{20}); some of the initial classical physical laws remain hence $(P_{19}-)$, new laws (P_n) were introduced such as general relativity, quantum physics, etc.

Despite the advances, in foundational physics, the list of unsolved problems and anomalies is increasing. The recent anomaly, the *ecliptic alignment of cosmic microwave background anisotropy*, drew following commented from physicist Lawrence Krauss [7]:

> *Is this Copernicus coming back to haunt us? That's crazy. We're looking out at the whole universe. There's no way there should be a correlation of structure with our motion of the earth around the sun - the plane of the earth around the sun - the ecliptic. That would say we are truly the centre of the universe.*

Clearly, something in our basic fundamental understanding is amiss; sound advice has been given:

> *One must replace thinking habits with thinking necessity.*[1] (Albert Einstein) Meaning that: *You cannot solve a problem from within the same paradigm of thinking that created it.* Commonly quoted by coaches when trying to motivate innovative solutions to a problem.
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> *Now, the task is not to see what has never been seen, rather it is to think about that what everyone has seen, in a way that nobody had ever thought.*[2] (Erwin Schrödinger) That is the basis that really defines innovative imagination that ultimately drives discovery.

In the spirit of the above two quotes, the essay topic *Questioning the Foundations* is approached in a novel way. I request you to step out of your paradigm while I explain[3] why the unemployed, brilliant mathematician and astrophysicist, Tricia Marie McMillan, changed her name to Trillian Astra. You may recall that she eloped with Zaphod Beeblebrox, latter from the planet Betelgeuse Five [1].

2 PHYSICS FROM BETELGEUSE

The unimaginable is happening to Tricia: Yesterday at a party she met Zaphod; this morning she is sitting in his spaceship; earlier admiring Saturn; now the Sun distant like any other star. Zaphod's next stop is Damogran, a planet of the star Sol.

"Wow... this is fantastic," rejoiced Tricia, "why on Earth could we not develop this technology?"

"Your ansatz is not correct." replied Zaphod.

"Explain...?"

2.1 GRAVITATIONAL-MASS-ENERGY EQUIVALENCE

Zaphod begins by explaining that the Betelgeuseans believe that gravitational and electric-charge forces are manifestations of similar primordial interactions. Space harbours particles, thus particles interact only with space, i. e. a particle modifies the surrounding space and the resultant change in space influences the behaviour of distant particles, and vice-versa; this particle-space-particle interaction is observed as a particle-particle interaction.

"A particle has three *energy forms*; mass, kinetic, and potential energy." explained Zaphod, "In a universe as a whole, the sum of these three energy forms is always constant."

"Let's take a closer look at the gravitational interaction. Consider the following thought experiment:" Zaphod elaborates, "A universe with only two stationary and uncharged infinitesimal small particles of mass M and m respectively, and these are separated by near infinite distance.

"This universe has an energy content of

$$E = (M + m)c^2 \tag{1}$$

where c is the speed of light in empty space. These two particles, without external influence but under the mutual gravitational attraction, will accelerate and move towards each other." stated Zaphod and continues with the thought experiment.

"When the particles are a distance r apart, the total energy of the universe remains unchanged. As each particle now has kinetic energy, this must be equal to the gravitational potential energy defined as GMm/r for both M and m stationary. The gravitational-mass-energy equivalence is expressed as

$$\left(Mc_R^2 + \frac{GMm}{r}\right) + \left(mc_r^2 + \frac{GMm}{r}\right) = (M + m)c^2 \tag{2}$$

1 Man muß die Denkgewohnheiten durch Denknotwendigkeiten ersetzen

2 Also, die Aufgabe ist nicht zu sehen, was noch nie jemand gesehen hat, sondern über dasjenige was jeder schon gesehen hat zu denken was noch nie jemand gedacht hat.

3 Apologies to Douglas Adams

where G is the Newton gravitational constant; c_R and c_r the local speed of light at M and m respectively; and r the distance between M and m."

"Energy preservation always makes sense." commented Tricia, "Our theories are based on an invariant speed of light for all observers. From your thought experiment the local speed of light varies

$$c_R = \sqrt{c^2 - \frac{Gm}{r}} \quad \text{and} \quad c_r = \sqrt{c^2 - \frac{GM}{r}} \tag{3}$$

"How do you explain this?" she asked.

"We think all matter as electromagnetic waves." clarified Zaphod,"The three energy forms (mass , kinetic, and potential) each result from a particular alignment of an electromagnetic wave in space." clarified Zaphod and he elaborates, "Space characteristics are modified by the presence of matter; this then mediates the realignment of the energy forms in matter elsewhere located, but it can never change the total energy content of the distant matter; this manifests itself, what you observe, as a gravity field. The change in the space characteristics, caused by the distant matter, also alters the local speed of light."

"Your description of the gravitational interaction has a different basis to ours. Our theories correctly described the planetary orbits." remarked Tricia and asks, "Can you, with your theory, explain the precession of elliptical orbits?"

"Yes we can," confirmed Zaphod, "starting with the gravitational-mass-energy equivalence (Equation 2), the one-dimensional effective potential $V_m()$ for the orbit of m around M can be deducted by using algebraical techniques." Zaphod, using pen and paper, quickly demonstrates (Endnote A.1) that for $M >> m$,

$$V_m(r_o) \approx \frac{L_m^2}{2mr_o^2} - \frac{GMm}{r_o} - \frac{GML_m^2}{mc^2r_o^3} \tag{4}$$

where the distance r_o is from m to the barycentre Mm; and L_m is the angular momentum of m, which is an additional preserved quantity in orbits, energy is the other.

''Wow! This result is the same as that was obtained using the Schwarzschild's exact solution to Einstein's field equations [6]." exclaimed Tricia and confirms, "The precession of Mercury's elliptical orbit was deducted correctly from this result."

However, Tricia elation subsides, "Let me summarise, you imply that massive particles are electromagnetic waves having some energy, this energy you relate to mass by $E = mc^2$; let's name this the gravitational mass; subsequently in your further reasoning, you assume that the gravitational mass is equal to the inertial mass. You cannot just do that without defining that these are indeed equal." criticised Patricia and asks, "How do you explain inertial mass in terms of gravitational mass and the fact that it dilates with velocity?"

2.2 ENERGY AND SPACE

Zaphod explains that the Betelgeusean view is that the universe is the manifestation of two entities, space and energy. Space's role is to transport the energy, which from a mathematical point of view, can only be described by the wave equation. He continues, "We believe that the existence is just a disturbance in space; this includes the physical observed, e. g. galaxies, as well as our thoughts and consciousness; all can ultimately be reduced to a *swarm of waves*, each wave fulfilling the constraints of the electromagnetic wave theory, the same as derived by Maxwell."

"The only waves in space we have observed are those manifested by the electromagnetic phenomena." interrupted Tricia and asserts, "These always propagate at the speed of light, your swarm of waves and light cannot coexists!"

"Tricia, your way of thinking is trapped in three dimensions; we think of space with more than three dimensions, defined by the orthogonal axes $x, y, z, u, \ldots$, in addition each axis has an associated invisible *quadrature* counterpart $i, j, k, l, \ldots$ respectively; you call these imaginary axes.

"In hyper-space, a particle, which is a wave, always has to propagate at the speed of light in some direction defined by a vector $\vec{\vartheta}$; however, in the observable three dimensions that particle can have any velocity between zero and the speed of light, depending on the orientation of $\vec{\vartheta}$."

Tricia interjects, "What has hyper-space got to do with mass?"

"The inertial mass and the so-called phenomena of mass dilation can, mathematically and logically, be derived from: Maxwell's laws, wave theory, conservation of linear momentum, and the assumption of a hyper-space. As an example let's analyse a collision of two particles in a four-dimensional space $\mathcal{S}[x, y, z, u]$

"Assume a particle of mass m; it has energy $E_1 = mc^2$; it is stationary at the origin in the observable three dimension $\mathcal{S}[x, y, z]$; as a wave it has an unobservable momentum[4] vector $\vec{\rho}_1 = \vec{u}^{E_1}/c$ in the invisible dimension along the u-axis defined by unit vector $\vec{u}$.

"The second particle, a photon, propagating along the x-axis, is characterised by having a momentum vector $\vec{\rho}_2 = \vec{x}^{E_2}/c$, where E_2 is the energy of the photon.

"The photon collides with the first particle and fuses. The momentum of the fused particle is the vector sum of the momentums before the collision and is of magnitude $\rho_3 = \sqrt{\rho_1^2 + \rho_2^2}$; i. e. it's energy is $E3 = c\rho_3$.

"The new particle of energy E_3 is now propagating at the speed of light in the x-u plane. Its velocity parallel to the x-axis is $v = {}^{cE_2}/_{E_3}$. Solving E_3 in terms of m, v and c we obtain

$$E_3 = \frac{mc^2}{\sqrt{1 - v^2/c^2}} \tag{5}$$

"This answers your questions regarding mass." concluded Zaphod and quickly adds, "Not forgetting, as $E_1 + E_2 > E_3$, further particles are produced carrying away the excess energy with zero nett momentum."

"Nobody ever thought that way before." exclaimed Tricia; slowly grasping the essence of the Betelgeusean way of thinking, however she still has doubts.

"From what you have explained you assume length and time are invariant and the speed of light varies." summarised Tricia; hoping that Zaphod is in error she recalls the famous experiment that failed, and asks, "Do you know the Michelson-Morley [8] experiment of 1887?"

"Yes."

"It was 18 years later that the accepted explanation was given by Einstein [4] using principles of special relativity." Confidently she asks, "How do you explain the null result?"

"We also conducted this experiment," replied Zaphod, "we were equally puzzled at first. However, our conclusion falsified special relativity."

"What..." cried out Tricia, "I do not believe you!"

2.3 THE MICHELSON-MORLEY-EINSTEIN INFORMATION PARADOX

Zaphod explains that the Betelgeuseans only accept a proposition if and only if all aspects of an observation are explained by the proposition.

"Take the case of the Michelson-Morley experiment," continued the explanation of Zaphod, "the following four aspects of the experiment need to be confirmed by theory: Firstly, the time of flight; secondly, the phase relation taking doppler effects into account; thirdly, the

4 A non relativistic derivation of $p = {}^{E}/_{c}$ in [5]

light path geometry; and fourthly, the information content within the apparatus."

"How do you define information content?" asked Tricia.

"The information content we defined as the number of light cycles within the apparatus; this is synonymous to quantifying the energy content of the light beam confined within the Michelson-Morley interferometer at any given instance of time. From Planck's relation $E = hf$, it can be said that, one cycle of a light wave of frequency f is equivalent to an energy quanta h.

"Special relativity transformation explain the first three aspects of the experiment, however the proposition of special relativity fails to confirm the fourth aspect. Special relativity predicts (Endnote A.2) the information or energy content E_0 and E_v in the respective reference frames X_0 and X_v as

$$\begin{aligned} E_0 &= \frac{4hf_0L(c^2+v^2)}{c(c+v)\sqrt{c^2-v^2}} \\ E_v &= \frac{4hf_0L}{c}\sqrt{\frac{c-v}{c+v}} \end{aligned} \tag{6}$$

where the light source, of frequency f_0, is in the stationary reference frame X_0; and the Michelson-Morley apparatus is in uniform translatory motion of velocity v defined by X_v."

"Special relativity theory actually predicts that the energy contained in the light beams, limited by the extent of the Michelson-Morley apparatus, varies depending on the reference system we care to choose; this cannot be!" explained Zaphod and reasserts, "This clearly contradicts the first axiom[5] of special relativity [2]; the energy content is a physical state. We have, consequently, rejected the special relativity theory."

5 *The laws by which the states of physical systems undergo change are not affected, whether these changes of state be referred to the one or the other of two systems of co-ordinates in uniform translatory motion.*

"Next you are going to tell me that there are no black holes." said Tricia in a sarcastic tone.

"Correct Tricia, black holes are merely modelling artifacts of your theories, our theories do not have singularities; they do, however, predict a maximum energy density of supermassive bodies."

2.4 THE DENSITY LIMIT

Zaphod asked Tricia to consider the earlier thought experiment; but this time, for brevity, with two equal masses m.

"If these two particles are a distance Gm/c^2 apart, what is the force of attraction?" he asked.

"Easy, c^4/G thats Planck's force" answered Tricia.

"And, if the distance is a bit less?"

"Then the force is a bit more." replied Tricia confidently.

"No," corrected Zaphod, "the direction has changed, it is now a force of repulsion."

"How can that be?" asked Tricia.

"The gravitational force a particle experiences, is defined as the derivative of mc_r^2 with respect to r. i. e. $F_g = d(mc_r^2)/dr$" explained Zaphod, and points out, "The direction of the gravitational force changes at the event horizon $r = Gm/c^2$ as the local speed of light $c_r = \sqrt{c^2 - \frac{Gm}{r}}$ becomes complex."

"The two particles are held together at the event horizon, now the two combined have a mass of $2m$ and in unison are free to interact with any new particles we may want to introduce to our *experimental* universe."

"This can continue ad infinitum," said Tricia and continues, "all the particles are attracted to the outside of the event horizon, any one of these can be accelerated to escape the gravitational grasp; if a particle is pushed inside by some force or other, it is pushed outwards just inside the event horizon; it cannot be pulled forever into a singularity as we believe on Earth."

"Bravo," praised Zaphod, "just one correction: An elementary particle has a finite dimension; it straddles the event horizon half inside halve outside, the force on the particle is neutralised, one half pushing out the other half pulling in. Bodies formed this way are the densest nature allows."

Tricia now unsettled; the foundations of her scientific believe are no longer as solid as they used to be. She ponders over that what she learned.

"Zaphod," called Tricia seeking his attention, she asks, "how would you explain the isotropy of light without special relativity?" and adds, "Surely, you do not believe in a luminiferous aether that flows like water in space?"

"Correct, we also rejected aether theories," confirmed Zaphod, "we think space, not only as multidimensional, but also as structured."

2.5 STRUCTURED SPACE

Zaphod explains that the Betelegeuseans model space as a lossless media in which energy, a electro-magnetic phenomena, can be transported. Instead of defining space by the electric permittivity ϵ_0 and magnetic permeability μ_0, they define space by its *electric elasticity* $\bar{\epsilon}$ (i. e. the reciprocal of permittivity) and the *space energy transport admittance* Y (i. e. the inverse of the characteristic impedance of vacuum.) In hyperspace the speed at which energy propagates, as an electro-magnetic wave, is $c = \bar{\epsilon}Y$ or $c = {}^{\bar{\epsilon}}/_{Z}$ where $Z = {}^{1}/_{Y}$ and Z is referred to as the *space energy transport resistance* of space.

"And what about the magnetic permeability?" asked Tricia.

"We prefer to use the *magnetic reluctancy* $\bar{\mu}$ (i. e. the reciprocal of permeability.)" explained Zaphod, "From Maxwell equations, the wave equation is derived

$$\frac{\partial^2\psi}{\partial t^2} = \bar{\epsilon}\bar{\mu}\frac{\partial^2\psi}{\partial \mathcal{S}^2} = \frac{\bar{\epsilon}^2}{Z^2}\frac{\partial^2\psi}{\partial \mathcal{S}^2} \tag{7}$$

where $\frac{\partial}{\partial \mathcal{S}}$ could for instance represent just a single partial differential $\frac{\partial}{\partial x}$, or be representative for $\nabla = \frac{\partial}{\partial x} + \frac{\partial}{\partial y} + \ldots$, or any other form of partial differential we care to define in the hyperspace."

"But that is exactly the same result we have, there is no difference!" commented Tricia impatiently.

"You asked me to explain the structure," reminded Zaphod and continues, "this, I can only do in terms of electric elasticity and space energy transport resistance; by doing so we automatically explain the isotropy of light by solving the wave equation, as formulated by Maxwell, using a invariant cartesian space and invariant time."

"You have my attention" reassured Tricia.

"Instead of assuming the electric elasticity as a scalar we think it as a vector in its own mathematical space $\mathcal{S}[E, F, G, \ldots]$; in free space $\vec{\bar{\epsilon}}$ is aligned with the E-axis and is of magnitude $\bar{\epsilon}$. Any disturbance in space rotates this vector. The magnitude of the projection of $\vec{\bar{\epsilon}}$ onto the E-axis is denoted by $\bar{\epsilon}_E$; similarly, $\bar{\epsilon}_F$ and $\bar{\epsilon}_G$ are the projections onto the F and G-axis respectively. This structures space.

"Earlier we discussed how the speed of light varies near massive bodies $cr = \sqrt{c^2 - {}^{GM}/_{r}}$ (Equation 3.) This we can explain by setting $\bar{\epsilon}_F = 0$ and $\bar{\epsilon}_G^2 = {}^{GMZ^2}/_{r}$, thus the vector $\vec{\bar{\epsilon}}$ is rotated towards the G-axis. Therefore, $\bar{\epsilon}^2 = \bar{\epsilon}_E^2 + \bar{\epsilon}_G^2$, introducing this vector addition result into the wave equation (7) we obtain

$$\begin{aligned}\frac{\partial^2\psi}{\partial t^2} &= \frac{\bar{\epsilon}^2}{Z^2}\frac{\partial^2\psi}{\partial \mathcal{S}^2} \\ &= \left(\frac{\bar{\epsilon}_E^2}{Z^2} + \frac{\bar{\epsilon}_G^2}{Z^2}\right)\frac{\partial^2\psi}{\partial \mathcal{S}^2}\end{aligned} \tag{8}$$

"This we solve in two parts, the first part explains the local speed of light $c_r = c_e$ in the observable three-space. The second part, only has a solution along an invisible axis in hyperspace. In this case, the vector sum of these two velocities equals c. This implies that near massive bodies all matter has a velocity component

of magnitude $\sqrt{GM/r}$ along an invisible axis of $\mathcal{S}[x, y, z, \ldots]$."

"That is neat" commented Tricia.

"Now," continued Zaphod, "near a massive body, which is in translatory motion having a velocity v_f as referenced to an absolute reference system, the electric elasticity vector $\vec{\bar{\epsilon}}$, in $\mathcal{S}[E, F, G,]$ is not only rotated by the gravitational phenomena towards G-axis; in addition, it is rotated towards the F-axis, the amount dependent on v_f and a function $\mathcal{R}()$ which is dependant on the position of the reference frame relative to the massive body, such that $\bar{\epsilon}_F = \mathcal{R}()v_f Z$."

"I can see where you leading to," replied Tricia and preempts, "if $\mathcal{R}() = 1$, as the laboratory is massive, the wave equation (7) now expands to

$$\begin{aligned} \frac{\partial^2 \psi}{\partial t^2} &= \frac{\bar{\epsilon}^2}{Z^2}\frac{\partial^2 \psi}{\partial \mathcal{S}^2} \\ &= \left(\frac{\bar{\epsilon}_E^2}{Z^2} + \frac{\bar{\epsilon}_F^2}{Z^2} + \frac{\bar{\epsilon}_G^2}{Z^2}\right)\frac{\partial^2 \psi}{\partial \mathcal{S}^2} \end{aligned} \tag{9}$$

"Correct," replied Zaphod, "a wave now has three vector velocity components, the first $c_e = \bar{\epsilon}_E/Z$ into any direction of $\mathcal{S}[x, y, z]$, the second velocity component of magnitude v_f is aligned with the laboratory motion and the third velocity component on an invisible axis as I described earlier. The propagation speed of a wave at a particular point is the vector sum of these three components, this explains the isotropic nature of light."

"I am impressed," praised Tricia and asks, "does this also explain the doppler shift?"

"Yes it does," confirmed Zaphod and continues his explanation, "a photon emitted from the moving laboratory has a momentum vector

$$\vec{p} = hf\frac{\vec{c}_e + \mathcal{R}()\vec{v}_f}{c^2} \tag{10}$$

where h is the Planck constant an f the frequency. At the emission point $\mathcal{R}() = 1$. After some time, when the photon has travelled to near free space then $\mathcal{R}() \approx 0$, its speed has now normalised to c, however the momentum has to be the same, therefore the frequency of the photon compensates by $|\vec{c}_e + \vec{v}_f|/c$ "

"That all makes sense." said Tricia, she still has a problem, "The electrodynamics of charged particles we could only explain on the strength of relativity theory; the design equations of particle accelerators embed relativity theory, and these work exactly as designed. I am now puzzled how you will explain the electromagnetic forces on an electron."

2.6 THE ELECTRIC PHENOMENA

Zaphod explains that the Betelgeusean reached the logical conclusion that the electric-charge field radiating from a charged particle is a different phenomena to the electric-potential field set up between the plates of a capacitor; the reason is that a charged particle accelerating in an electric-potential field gains energy as witnessed in accelerators, whereas the total energy remains unchanged if particles accelerate under mutual attraction/repulsion due to the gravitational and/or electric-charge interaction.

"The earlier gravity thought experiment (Section 2.1) is equally valid if charged particles are considered." explained Zaphod and reasserts, "When particles accelerate under forces generated by the gravitational and/or electric-charge fields, then the total energy of each particle is invariant.

"As the gravitational and electric-charge forces are so similar in character, both these forces are subjected to the same underlying physical phenomena," proceeded Zaphod, "we thus believe that mass has a real part and a quadrature part. The real part is responsible for gravitational mass phenomena and the quadrature part for the electric-charge phenomena.

"The mass-energy equivalence we formulate as

$$E = (m + jq')c^2 \tag{11}$$

where the quadrature operator is defined by $j^2 = -1$ and we recognise that energy has a quadrature component. The electric-charge q' has units quadrature kilogram. At rest, the relationship $q = q'\sqrt{4G\pi\epsilon_0}$ defines the magnitude of q of units coulomb in terms of q' of units [jkg]."

"The total force acting on two charged particles then is?" asked Tricia.

Zaphod writes down the equation

$$F = G\frac{(m_1 + jq'_1)(m_2 + jq'_2)}{r^2} \tag{12}$$

and explains, "The mutual attraction/replusion force of two charged particles has three parts: The first describing the gravitational attraction as formulated by Newton; the second describing Coulomb's law of electric attraction/repulsion; and the third is a quadrature force

$$F_j = jG\frac{(m_1 q'_2 + m_2 q'_1)}{r^2} \tag{13}$$

"The secrets of this quadrature force, you on Earth, have yet to explore and discover."

"That does not fully answer my question," replied Tricia and clarifies, "I actually meant the forces on an electron as described by Lorentz force law $F = qE + qv \times B$"

"I am trying to explain these," said Zaphod, "the electric-charge and electric-potential fields are two different phenomena. The mass m and charge q' are manifestations of space transporting energy.

"The transporting of energy you observe as the electromagnetic phenomena. The electromagnetic phenomena is the manifestation of potential fields in space. The potential field is an energy field that can transfer its energy e. g. electric to magnetic, electric to kinetic, etc.

"As the charge q' dilates, led us to the modification (Endnote A.3) of the Lorentz force law, expressed

$$\vec{F} = \frac{\sqrt{4G\pi\epsilon_0}}{\sqrt{1 - v^2/c^2}}\left(q'\vec{E}\sqrt{1 - (v\cos\alpha)^2/c^2} + \frac{q'\vec{v} \times \vec{B}}{\sqrt{1 - (v\sin\beta)^2/c^2}}\right) \tag{14}$$

where $\vec{E}$ is the electric-potential field vector; $\vec{B}$ the magnetic field vector; $\vec{v}$ the velocity vector of the charged particle; α the angle between the velocity vector and electric-potential field vector; and β the angle between the velocity vector and the magnetic field vector.

"Finally, by setting $\alpha = 0$ and $\beta = \pi/2$ in the modified Lorentz force law, (Equation 14) then reduces to $\vec{F} = q'\sqrt{4G\pi\epsilon_0}\left(\vec{E} + \gamma^2\vec{v} \times \vec{B}\right)$ and as both space and time are invariant the centrifugal force[6] is $F_c = \gamma^3 mv^2/r$. Therefore there is no change in the design equations of a synchrotron."

And so it carried on, for every question concerning basic physical principles that Tricia asked, Zaphod confidently gave an alternate explanation. On the other hand, Tricia, as hard as she tried, could not find an explanation for the Michelson-Morley-Einstein information paradox.

Some time later, "We have arrived," announced Zaphod, "look, there to the right, the planet Damogran."

"Beautiful," exclaimed Tricia; turning to Zaphod; smilingly she discloses, "Your physics has convinced me, I am converting to the Betelgeusean paradigm; the name Trillian Astra suits me better now. Do you like it?"

6 Special relativity predicts $F_c = \gamma mv^2/r$

3 CONCLUSION

Betelgeusean physics, be it fact or fiction, is different; yet nature is the same. Is there an explanation why two different approaches can describe the same? The Betelgeuseans could not resolve the Michelson-Morley-Einstein information paradox (Section 2.3); consequently they found an alternative explanation to nature, by adopting a hyper-space together with a different set of fundamental principles.

In essence, the Betelgeuseans have chosen a hyper-dimensional geometry (G_b) in which the electromagnetic phenomena can unfold. They then chose a different purport of physical laws (P_b) so that $(N_b) = (G_b) + (N_b)$, as a whole, is in accord with experience; a method completely in unison with Poincaré's thinking, as described in Einstein's 1921 address [3]

> *...and we feel impelled toward the following more general view, which characterises Poincaré's standpoint.*
>
> *Geometry* (G) *predicates nothing about the relations of real things, but only geometry together with the purport* (P) *of physical laws can do so. Using symbols, we may say that only the sum of* $(G) + (P)$ *is subject to the control of experience. Thus* (G) *may be chosen arbitrarily, and also parts of* (P)*; all these laws are conventions. All that is necessary to avoid contradictions is to choose the remainder of* (P) *so that* (G) *and the whole of* (P) *are together in accord with experience. Envisaged in this way, axiomatic geometry and the part of natural law which has been given a conventional status appear as epistemologically equivalent.*
>
> *Sub specie aeterni Poincaré, in my opinion, is correct. ...*

Really? I beg to differ. Both the Betelgeusean and our paradigm seemingly describe nature equally well, one differently to the other; one may have greater explanation power, but both cannot be correct. Ultimately, there is one and only one (G) and one and only one (P).

There is no easy answer to the question: *Which of our basic physical assumptions are wrong?* The contemporary (20th century) paradigm, $(N_{20}) = (G_{20}) + (P_{20})$, believes that all its assumptions are correct, any changes in any basic physical assumption of purport (P) go hand in hand with a change in geometry (G). Changing a basic physical assumption cannot be done in isolation, it is either all or nothing!

I am of the belief that, if the full force of the scientific knowledge is now mobilised to define a new geometry (G_{21}) together with a new set of physical laws (P_{21}), that the resulting revised description of nature (N_{21}) would surpass our current understanding. It would also be the beginning of the next scientific epoch. The idea may not be new, but the need for courage to embrace fundamental change is required.

I leave you with the following provocation: *Assuming that Zaphod's way of thinking had been known at the end of the 19th century, would today's scientific theories be the same?* Logical reasoning leads me to only one answer (which is not forty-two [1].) Thus, my next question is not if, but rather: *When will a paradigm shift, of unprecedented proportion and consequence, symbolically expressed* $(N_{21}) = (G_{21}) + (P_{21})$ *rewrite physics?* After all, Einstein's 1921 address [3], titled *Geometry and Experience* was opened with this warning:

> *One reason why mathematics enjoys special esteem, above all other sciences, is that its laws are absolutely certain and indisputable, while those of all other sciences are to some extent debatable and in constant danger of being overthrown by newly discovered facts.*

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A ENDNOTES

A.1 ENERGY, GRAVITY & ORBITS

Starting with the assumption

$$(M+m)c^2 = \left(Mc_R^2 + \frac{GMm}{r}\right) + \left(mc_r^2 + \frac{GMm}{r}\right) \tag{15}$$

Solving for c_r and c_R in terms $G, M, r,$ and c

$$c_r = \sqrt{c^2 - \frac{GM}{r}} \quad \text{and} \quad c_R = \sqrt{c^2 - \frac{Gm}{r}} \tag{16}$$

Let M and m orbit each other at a distance r we define:

$$x = m/M \quad \text{such that} \quad r = (1+x)r_o \tag{17}$$

and assuming the kinetic energy to have following fraction of the potential energy

$$\begin{aligned} \frac{mv_m^2}{2} &= \frac{mc^2 - mc_r^2}{2(1+x)} = \frac{GMm}{2(1+x)r_o} \\ \frac{Mv_M^2}{2} &= \frac{Mc^2 - Mc_R^2}{2\frac{(1+x)}{x}} = \frac{GMm}{2\frac{(1+x)}{x}r_o} \end{aligned} \tag{18}$$

the orbiting velocities v can be solved as:

$$v_m = \sqrt{\frac{GM}{r_o(1+x)}} \quad \text{and} \quad v_M = \sqrt{\frac{Gmx}{r_o(1+x)}} \tag{19}$$

as $m = xM$ thus

$$v_M = \sqrt{\frac{GMx^2}{r_o(1+x)^2}} = xv_m \tag{20}$$

The centrifugal forces for both M and m evaluate to

$$\begin{aligned} F_c &= \frac{mv_m^2}{r_o} = \frac{Mv_M^2}{xr_o} \\ &= \frac{GMm}{r_o^2(1+x)^2} \end{aligned} \tag{21}$$

which equals the gravitational force m under the gravitational field of M determined by the differential equation:

$$F_g = \frac{d(mc_r^2)}{dr} = \frac{GMm}{r^2} = \frac{GMm}{r_o^2(1+x)^2} \tag{22}$$

thus validating (18). Furthermore, the effective potential of the orbit of m and M is

$$\begin{aligned} V_m(r_o) &= \frac{L_m^2}{2mr_o^2} - \frac{GMm}{r_o(1+x)} \\ V_M(xr_o) &= \frac{L_M^2}{2mx^2r_o^2} - \frac{GMm}{r_o(1+x)} \end{aligned} \tag{23}$$

The angular momentums $L_m = mv_m r_o$ and $L_M = Mv_M x r_o$ both need to be conserved; and from the relations $m = xM$ and $v_M = xv_m$ it follows that $V_M(xr_o) = V_m(r_o)$. Multiplying and dividing the second term of (23) with c^2, thus

$$V_m(r_o) = \frac{L_m^2}{2mr_o^2} - \frac{GM}{c^2r_o(1+x)}mc^2 \tag{24}$$

and from equation (15) as well as remembering that $r = (1+x)r_o$ it follows

$$mc^2 = mc_r^2 + \frac{GMm}{r0(1+x)} \tag{25}$$

the using equation (19) we rewrite

$$mc^2 = mc_r^2 + (1+x)mv_m^2 \tag{26}$$

and substituting $L_m = mv_m r_o$ into the second term

$$mc^2 = mc_r^2 + (1+x)\frac{L_m^2}{mr_o^2} \tag{27}$$

and working this result (27) into (24) to obtain

$$V_m(r_o) = \frac{L_m^2}{2mr_o^2} - \frac{GM}{c^2r_o(1+x)}\left(mc_r^2 + (1+x)\frac{L_m^2}{mr_o^2}\right) \tag{28}$$

Using (16) and (17) and if

$$c^2 >> \frac{GM}{r} \quad \text{and} \quad 1 >> x = \frac{m}{M}$$

then $c_r \approx c$ and $r \approx r_0$ thus the effective potential (23) of the orbit approximates to

$$V_m(r_o) \approx \frac{L_m^2}{2mr_o^2} - \frac{GMm}{r_o} - \frac{GML_m^2}{mc^2r_o^3} \tag{29}$$

A.2 MICHELSON-MORLEY & EINSTEIN

Using the special relativity (SR) transformations Fig. 1 defines in terms of time and frequency the light beams as observed from a stationary reference system of a moving Michelson-Morley apparatus. A light source frequency f_0 is assumed in the stationary reference frame. For the light beams in leg $AC'A''$ and $AB'A''$ the time of flight equivalence is given by

$$t_{AC'} + t_{C'A''} = t_{AB'} + t_{B'A''} \tag{30}$$

and phase equivalence by following:

$$t_{AC'}f_{AC'} + t_{C'A''}f_{C'A''} = t_{AB'}f_{AB'} + t_{B'A''}f_{B'A''} \tag{31}$$

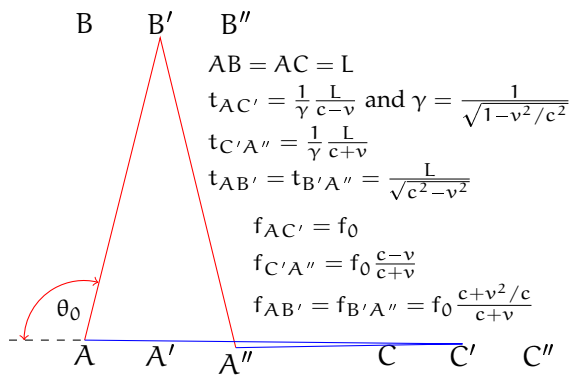

Figure 1: Michelson-Morley Analysis.

By using the Huygens-Fresnel principle, the angle that the moving mirror reflects the light beam is calculated as

$$\begin{aligned}\theta_0 &= \pi - 2\arctan\frac{AB}{AC'} \\ &= \pi - 2\arctan\frac{1-v/c}{\sqrt{1-v^2/c^2}} \\ &= \frac{\pi}{2} + \arcsin\frac{v}{c}\end{aligned} \tag{32}$$

Thus special relativity transformation confirm: Equal time of flight and equal phase considering time and doppler shifted frequencies in each leg, as well as the physical reflection angle of the light beam off the mirror at A corresponds to the assumed. Are these three tests enough to confirm that special relativity explains the null result? Considering that a physical sate of the Michelson-Morley interferometer is the information or energy content at any instance of time. This we define as the number of light cycles in the apparatus. Observed in the stationary reference system the number of cycles predicted by special relativity are

$$\begin{aligned}N_0 &= t_{AC'}f_{AC'} + t_{C'A''}f_{C'A''} \\ &\quad + t_{AB'}f_{AB'} + t_{B'A''}f_{B'A''} \\ &= \frac{4f_0L(c^2+v^2)}{c(c+v)\sqrt{c^2-v^2}}\end{aligned} \tag{33}$$

whereas in the moving reference system, and applying the relativistic doppler shift, the number of light cycles calculates to:

$$N_v = \frac{4f_0L}{c}\sqrt{\frac{c-v}{c+v}} \tag{34}$$

A.3 MODIFIED LORENTZ FORCE LAW

The simplified result

$$\vec{F} = q'\sqrt{4G\pi\epsilon_0}\left(\vec{E} + \gamma^2\vec{v}\times\vec{B}\right) \tag{35}$$

is obtained after following consideration.
(i.) Faraday's law of induction needs to be rethought. A particle in relative motion to and in the constant magnetic field $\vec{B}$ induces a electric field $\vec{E}_i$ across the particle such that

$$\vec{E}_i = \frac{\vec{v}\times\vec{B}}{\sqrt{1-(v\sin\beta)^2/c^2}} \tag{36}$$

where v is the velocity of the relative motion of particle and magnetic field and β the angle between the magnetic field vector and velocity vector. This is Faraday's law with a Lorentz correction. If the particle is charged a force is induced on the particle accordingly. Assuming a stationary charged particle the a force $\vec{F}_{i0} = q'\sqrt{4G\pi\epsilon_0}\vec{E}_i$ is induced. However, in a stationary magnetic field and a moving charged particle, the relative motion to the magnetic field remains but as the charge has dilated by the Lorentz factor γ the induced force

$$\begin{aligned}\vec{F}_{iv} &= \gamma F_{i0} \\ &= q'\sqrt{4G\pi\epsilon_0}\left(\frac{\vec{v}\times\vec{B}}{\sqrt{1-v^2/c^2}\sqrt{1-(v\sin\beta)^2/c^2}}\right)\end{aligned} \tag{37}$$

where v is the velocity of the charged particle and β the angle between the stationary magnetic field vector and velocity vector.
(ii.) The definition of the stationary electric-potential field $\vec{E}$ at a point in space is defined as the force $\vec{F}_e$ experienced by a stationary positive unit point charge q, thus the force on a stationary charged particle $\vec{F}_e = q'\sqrt{4G\pi\epsilon_0}\vec{E}$. Once the particle has velocity its charge has dilated and to be in accord with experience and (i.) above the

$$\vec{F}_e = q'\sqrt{4G\pi\epsilon_0}\left(\frac{\sqrt{1-(v\cos\alpha)^2/c^2}}{\sqrt{1-v^2/c^2}}\vec{E}\right) \tag{38}$$

where v is the velocity of the charged particle and α the angle between the stationary electric field vector and velocity vector.
(iii.) By setting $\alpha = 0$ and $\beta = \pi/2$ then Euation (35) is obtained.