The Metaphysics of Physics

by
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Abstract: Most physicists claim Physics is free of Metaphysics. I question this *fundamental assumption* and argue this is not so. Ignoring *The Metaphysics of Physics* may be physicists' biggest mistake. The use of models (whether axiomatic or curve fitting) to describe *what is* the Universe is metaphysical in essence. Models have lead physicists to create a 'house of horrors' more phantasmagorical than any Metaphysics in the past [28]. With our minds twisted to believe in the reality of the unreal and the unreality of the real. Though the language and methods may differ, the fundamental assumptions of Physics are *metaphysical*. And all metaphysical descriptions of the Universe ultimately fail. Collapsing under their own unreality.

To avoid such fate Physics, I argue, should be based only on measurement and mathematical identities (*not* models) applied to measurement. Whereas a *model* is a *postulated theory* of *what is,* an *identity* is a *proven theorem* applied to *measurements[2]*. Such mathematical identity, for example, is the Pythagorean Theorem that can be used to describe measurement of lengths under right triangle conditions. I show Planck's formula for blackbody radiation is also such a *mathematical truism* and *not* a Physical Law [2, 10]. Like a *Rosetta Stone*, this result has lead to mathematical derivations of Basic Law in broad areas of Physics [2, 8]. Sensible insights open up as to the true meaning of *entropy* and *time* [2, 6]; the meaning and existence of Planck's constant h [2, 7]; the meaning and nature of the *wavefunction ψ* [2, 9]. And many other fundamental results. The Second Law of Thermodynamics I show to state *"every physical event takes some positive duration of time to occur"* [2, 6]. And I further prove the inconsistency between the *CSL Postulate* and the *Photon Hypothesis* [2, 18].

Biographical: In my retirement from teaching math I am pursuing lifetime interests. These included my FQXi 2010/11 essay *"A World Without Quanta?"*[3], the chapter *"The Thermodynamics in Planck's Law"* in the book **Thermodynamics: Interaction Studies** [2], and some 15 papers in the now defunct **G**oogle knols. Shame on you, Google! I have also proposed a *natural agency* explanation for Stonehenge in*"The un-Henging of Stonehenge"* [4] and in Brian John's blog *Stonehenge Thoughts* [38] and Robert Langdon's blog *Prehistoric Britain* [37].

Introduction: *"Metaphysics is a branch of philosophy concerned with explaining the fundamental nature of being and the world, although the term is not easily defined. Traditionally, metaphysics attempts to answer two basic questions in the broadest possible terms:*

1. "What *is there*?"
2. "What is it *like*?" *"* [36]

I use the term 'metaphysical' in its original meaning in Greek: 'beyond the physical'. What lies beyond the observable Universe. Beyond the empirical data and the calculations based on them. If the 'physical' is manifested in our measurements and calculations, the 'metaphysical' is hidden from our measurements and only believed to be true. These are our *fundamental assumptions*. What make possible our understanding of our physical Universe.

There is a feud going on between physicists and philosophers. With physicists being especially dismissive of philosophers. In a New York Times article on June 8, 2012 Jim Holt writes, *"Why do physicists have to be so churlish toward philosophy?"* And in a 'related opinion', *"Physicists say they do not need any help from philosophers. But sometimes physicists are, whether they realize it or not, actually engaging in philosophy themselves."* [35]

Bad manners and arrogance is not the problem. But this misbehavior reflects a deeper intellectual attitude which is keeping physicists locked unaware in a *metaphysical* box. Just when they need to think outside the box. Such hostile attitudes by 'keepers of exclusive knowledge' is reminiscent of Scholasticism. And betray intolerance to heretical views. What every religion claiming true and universal knowledge has done in the past. Modern Physics is morphing into Scholastic Metaphysics.

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2 Premises to a theorem are different from the physical claims a model makes of what is the Universe. The application of the Pythagorean Theorem to 'flat right triangles', for example, is different from the claim the 'world is flat'.

Paul Reed[3] in a FQXi post writes, *"But mine is not a view. It is a statement of fact, a logical truism, given how reality occurs. I am not interested in philosophy or belief. … We experience 'something'. It is independent of us, because others also experience it. 'Something' can only exist in one specific physically existent state at a time."* [34]

Believing '*others also experience it*' is not the question. Rather, what is 'it' is the real question. What Paul is arguing for here is the Being in Parmenides' philosophy some 2500 years ago [51]. To claim this is a '*logical truism*' argues for Paul's deep conviction. But Heraclitus [52] would disagree! Whereas Paul sees Being ('*one specific physically existent state*'), Heraclitus sees an ever changing Becoming. So which is more fundamental? Being or Becoming? In either case we'd be arguing endlessly for our metaphysical convictions. As Paul Reed and John Merryman have done in that thread.

We need not argue with St. Paul '*something happened*'. Just as we need not dispute the Universe exists independent of us. 'What' has happened and 'why' are the relevant questions here. And these cannot so easily be answered. These require Mind to know. And knowing depends on our particular perspectives, beliefs and prejudices. And on our past history. Our theories of the Universe. But a theory is a *view*. The very word 'theory' in Greek means 'divine view'. Every thought we have is a view we have. Physics without a view is thinking without a thought.

Our understanding is deeply rooted in the 'view' we have. If we believe in 'atoms', our explanations will be in terms of atoms. And if we believe in 'spirits', our explanation of 'what happened' will be in terms of spirits. In all cases, our *explanation* will only be a *description* of 'what happened'. Using words and ideas drawn from our beliefs. Though we can agree the Universe exists independent of us, our knowledge of the Universe cannot exist independent of our mind. Thus, how knowing happens is central to knowing what happened. And in this regard, the minds of physicists are no different than the minds of ordinary people. Only the beliefs and methods differ. To think otherwise is hubris!

The 'information content' [48] of the Universe cannot be any less than of a human mind.[4] Thus, seeking to know what is the Universe is no more possible than seeking to know another person, as they are truly. But we can only really know ourselves, our thoughts and feelings. Knowing another person truly is *being* the other person! But this is 'being in love'. *"To know her is to love her"*, as a song's lyrics celebrates. Physicists act like suitors to a maiden's head. Wooing her with gift-wrapped boxes of mathematical models. But never able to truly love her for herself. As Nature *is*. As this would require abandoning their calculations and judgments of *what* she is. And giving up their egotistical desires to win 'the Prize'.

A veil separates the observable, knowable Universe from the unknowable and unmanifested. What's behind that veil, because it's unknowable, can be anything. In such dark void we can see anything we wish and fear. Thus what is the Universe is only in the mind of the thinker. This is no less so in Physics than in Politics or Prehistoric Archeology. We thus create fantastic fabrications explaining 'what is' according to the beliefs we project on uncertain shadows in the darkness of Plato's cave.

Physicists claim Physics

A) … uses mathematics to deduce facts. In my FQXi 2011 essay, *"A World Without Quanta?"* [3] I write, *"Mathematics is a tool. It is a language of objective reasoning. But mathematical 'truths' are always 'conditional'. They depend on our presuppositions and our premises."*

And also, *"We can have beautiful mathematical results based on any view of the Universe we have. … But if the view leads to physical explanations [based on mathematics] which are counter-intuitive and defy common sense, or become too abstract and too removed from life and not supported by life, than we must not confuse mathematical deductions with physical realism. Rather, we should change our view! And just as we can write bad literature using good English, we can also write bad Physics using good Math. In either case we do not fault the language for the story. We can't fault Math for the failings of Physics.*

The failing of Physics is in not providing us with a 'physical view' that makes sense"

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3   The quote here is meant only as a spring board to discussion and is not meant to represent in any way Paul Reed's views or relevance to Physics.

4   Some physicists and other extraterrestrials have TOEed with *Consciousness*. *"… [Penrose argues] known laws of physics are inadequate to explain the phenomenon of consciousness"* (*http://en.wikipedia.org/wiki/Roger_Penrose 08/17/2012).* See also Wilhelmus de Wilde [46] and Sridattadev Kancharla [45] FQXi 2012 essays.

And more math wont "*Fix Physics!...*" [54]. As Vladimir F. Tamari exhorts, and Alexander G. Kyriakos warns in his essay "*Crisis in Physics: … "* [55]

Anthony Aquirre writes, "*It's a bit hard to explain this without the mathematics, I'm afraid, and in some sense that's precisely the point -- the structure of these models is something I at least would never have come up with any way other than following the mathematics where it went.*" [33]

The use of math in Physics does not make Physics immune to Metaphysics. The Pythagoreans are a good example of that. Math is also used in parlor magic tricks. But do we need to know the magician's trick to know the magic is not real? Perhaps in some sense the same is true in Modern Physics. Some mathematical deductions of physicists may turn out to be elaborate 'math tricks' taken as 'real' and even hidden from the 'QM-agicians'. I show 'energy quanta' and Planck's Law, for example, are *not* Universal Law of Physics! But simple *truisms* in mathematics [2, 10]. Just like the Pythagorean Theorem is. On the other hand, magic like 'time travel' and 'backward causation' are just not real. I trust my senses on this over any 'mathematical proof'. Though math provides 'logical certainty' it cannot provide the truth of what is the Universe. Nor can Physics! All math models of Physics that seek to describe what is the Universe lead eventually to metaphysical nonsense and unreality.

We know there are limits to math."*Gödel's incompleteness theorems … establish inherent limitations of all but the most trivial axiomatic systems capable of doing arithmetic*" [31]. Thus, I argue, any math model of what is the Universe will be limited and may therefore even distort our views of the Universe. And just as, according to Gödel's theorems, we can have *true* statements in any model which *can not* be mathematically proven; we can also have *false* statements about the Universe which *can* be mathematically proven. From Logic we know false statements can be proven to be true if our premises are false. Thus, if a math model makes false assumptions in its view of the Universe (as, for example, the Photon Hypothesis or the Spacetime continuum) we could mathematically prove what physically is *false*. But physicists are so lured by math they trust the math more than their senses. By doing so, the math models they create will not be 'faithful to Nature'. As Roger Schlafly also argues in his FQXi essay, "*Nature has no Faithful Mathematical Representation.*" [41]

Robert L. Oldershaw wrote in a FQXi post [32] "*… when mathematics is applied to modeling nature, the analytical models are: (1) Artificial (in the non-pejorative sense of the word, and more in the sense that the models are invented rather than discovered), and (2) Approximate (in the sense that they cannot in principle provide a complete representation of nature's infinite complexity). … We would do well to be mindful of the distinction between what is real and what is an abstraction.*"

I agree with that. And Eckard Blumschein [47] has similar reservations about the misuse of Math in Physics. Furthermore, I make the following additional argument. To mathematically know a quantity *E(t)* is to know its value for all values *t*. A fundamental question of Physics is this:

Can we know a physical quantity *E(t)* (energy, for example) directly by our measurements of it where in the interaction of measurement an amount *ΔE* is absorbed by the sensor at each absorption cycle and E_{av} is the average of *E(t)* at the sensor at each cycle?

I show it is not possible to know *E(t)* [2, 53]. Though our measurements will chart a 'linear function' of *E(t)* over time, the quantity *E(t)* can be *any* integrable function. Furthermore, the relationship between *E(t)* and the *ΔE* and E_{av} manifested in our measurements is a *Planck-like mathematical identity* that describes the *interaction of measurement*; the functional relationship between the quantity *E(t)* at the sensor at time *t*, the amount *ΔE* absorbed by the sensor, and the average E_{av} at the sensor for each absorption cycle. [2, 12]

With math identities that describe either measurement or the interaction of measurement we have *convergence* between theory and experiments[5]. Thus, the more accurate our measurements get the more indistinguishable the experimental graph and the theoretical curve get. This is clearly so with the Pythagorean Formula. And experimental data show this is also the case with Planck's Formula for blackbody conditions [29]. *There is no known explanation for this.* Other than awe and wonderment of how accurately Planck's Law fits Nature. But my result showing Planck's Formula is a mathematical identity *explains* this remarkable coincidence between theory and data [2, 10]. The equally remarkable accuracy and wide use of QM suggests QM likewise may be a mathematical truism that describe interactions of measurement for more complicated conditions. The close similarity of my equations defining energy

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5   Always assuming the premises to the theorem are satisfied.

and momentum (using the quantity *eta*[6]) and Schrödinger's equations, also argue this may be so [2, 9]. As with Planck's Formula (a *mathematical result*) QM may also be a *mathematical theory* of measurement interactions applied to Physics and to other fields as well.

The *convergence* of theory and experiments for mathematical *identities* describing measurements contrasts sharply with the typical *divergence* between mathematical *models* and the empirical data. Thus, with mathematical models the more closely we look into the physical phenomenon modeled the more *divergence* we typically have with our theoretical calculations. Forcing fine tuning of our model. The need to add more epicycles to our theoretical orbits.

B) … uses experiments to confirm theory. I agree. We simply cannot know the *truth* of our theories with 'armchair theorizing'. We need to experimentally test our hypotheses. If a hypothesis is not 'falsifiable' it cannot be measured or observed. It would not concern our Observable Universe. Thus, is not science.

But do we *find* or *create* our experimental outcomes in some cases? Is it not possible to reach a point with our technology and our ability to manipulate Nature when we are able to create the experimental outcomes we design into our sophisticated instruments? As we are now able to create new substances in Chemistry and new organisms in Biology not existing before in Nature?

In an FQXi article, *"The Crystallizing Universe"*, Kate Becker writes about the contradictory evidence of the double-slit experiment: [30]

"Gaze at the [detection] screen and you'll see an interference pattern generated by the light diffracting off the two slits and interfering on the other side. From this, you'd conclude that light must be a wave"

"Now [place] … two detectors-one lined up with each slit-that can register individual photons. When you now repeat the experiment without the screen, the detectors tell you that the photons are sailing straight through the slits like bullets, with no hint that an interference pattern could ever have been produced. From this experiment, you'd conclude that light must be a particle."

"Could it be that light somehow "knows" what kind of experiment it is entering, and adjusts its behavior accordingly? It seems impossible, but experiment after experiment shows that if you're looking for a wave, light will act like a wave. Seek a particle, and light will be every inch a particle. Confused? So were quantum physicists."

Light does not know! But the detectors we use know. And they know because that's how we designed them. What we are observing is not the nature of light but the nature of the instruments used for the experiment. We observe what the detector is designed by us to show [21]. This is no different than people seeing what they are looking for. Our instruments may be defining Reality in other ways as well. Just as our politicians and news media are defining our Political Reality by shaping what we think and how we see.

In our recent search for the Higgs boson (if confirmed) did we *find* it or did we *create* it? By designing our instruments according to our theories of its existence? When we whirl water in a tank, do we *find* the hole in the middle or *create* it? And if we similarly whirl plasma around and hurl it smashing against itself and occasionally find among the inexhaustible data some pattern that resembles our predictions, is it *evidence* or *coincidence*? Are the tracks in a cloud chamber caused by elementary particles or we interpret these to be caused by them? And couldn't we, using the same evidential logic, argue the tear in a fabric pulled apart is caused by an invisible 'particle' going through the fabric? Where is the fine line between *evidence* and *interpretation*? We discern our evidence using the same thinking and theories we use designing our instruments. With our advanced technology could we perhaps have built instruments producing *designer outcomes*?

We tend to find what we are looking for. Simply by ignoring all other occurrences. And we interpret the evidence according to our beliefs and the theories based on our beliefs. Our theories become filters to Reality. And our Knowledge the chiseled remains of a larger Universe. Thus our *view* of the Universe evolves to *become* the Universe. When it is only our view!

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6   The quantity *eta* can be thought as the time integral of energy. Planck's constant *h* is such a quantity. See below for more on this.

C) … is predictable and repeatable. We fit our mathematical models to the data points of our experiments. But how true can claims of predictability be if we need to modify our models with every new data point that does not fit our model? If our model does not pass through a data point close enough we add more terms; more degrees of freedom; more quarks and color; more epicycles to our theoretical orbits. More modern day angels dancing on our pinheads. And because our knowledge of 'what is' is coded in objective language, we call our knowledge science. We separate ourselves from our senses as we objectify our theories. But there comes a time when our *theoria* encapsulating our knowledge contradicts our senses. As is the case now with the many paradoxes of Physics. We have a choice to make. Do we trust our theories to tell us *what is* or do we trust our senses. History advises us to trust our senses. That's what every great mind in the past has done!

Mathematical models provide a coded methodology for organizing and cataloging the known facts in Nature's Library. But the Model is not the Library. Nor is it Nature. If using a search algorithm I enter the name of a book and get a coded ID where I can find the book in the Library; and using the code I find the book, have I predicted my findings? Assuming the Universe *here and now* is an orderly and well maintained Library and the mathematics that codes the 'facts of the Universe' is free of self-contradiction, I can be fairly certain I will come up with the experimental outcomes I have predicted. But if the mathematical model does not take me to the correct predicted outcome, I modify the model. And continue believing the Universe is in order. I do what all 'true believers' do. Trust in God even in contradiction.

The end of Metaphysics and the beginning of Physics

Physics is blurring and confusing 'object' with 'observation'. And trusting and believing math will lead us to the truth of what is the Universe. Physicists argue what is 'objective' must be 'observable' and what is 'observable' is 'objective'. What we see is all we get … and all we can know. Appearance is Reality and Reality is Math. Thus the only problem for Physics is finding the right mathematical model that describes the Universe. Physicists believe the Universe *can* be mathematically modeled. But this is a metaphysical belief! In his essay [41], Roger Schlafly also argues, " … *physicists commonly assume a faithful mathematical representation of nature, even if they do not admit it. They use the term "reality" to mean not just a physical reality, but also a linked mathematical reality that perfectly matches the physics."*

We shouldn't base Physics on metaphysical beliefs of what is unknowable to us. But starting with our measurements and limiting our theories to how measurements happen – never asking or answering the question *what is* the Universe – we can formulate physical theory that makes sense. And mathematical deductions that will not mislead us with mystical and metaphysical illusions. I sketch below my approach to such Physics. Starting with *eta*[7] as primary we can define the following physical quantities in terms of it:

$$\text{Prime physis :} \quad \eta = eta \text{ (energy-time-action)}$$

$$\text{Energy:} \quad E = \frac{\partial \eta}{\partial t}$$

$$\text{Momentum:} \quad p_x = \frac{\partial \eta}{\partial x}$$

$$\text{Force:} \quad F_x = \frac{\partial^2 \eta}{\partial x \partial t}$$

$$\text{Temperature:} \quad T = T_\eta = \left(\frac{1}{\kappa}\right)\frac{\eta}{\tau} \quad \text{where } \kappa \text{ is a scalar constant}$$

Note that the quantity *eta* is undefined. But it can be thought as '**e**nergy-**t**ime-**a**ction' in units of *energy-time*. Eta is both *action* as well as *accumulation of energy*. While the *wavefunction* is the *distribution of eta in space and time. Eta* represents 'what is' (being) while not describing 'what is'. Thus avoiding being metaphysical. We make only the following assumption about η .

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7   The quantity *eta (η)* can be thought as the time integral of energy in units of joule-sec. Planck's constant *h* is such a quantity. Though *η* is a *variable* while *h* is a *constant*.

Identity of Eta Principle: *For the same physical process, the quantity* η *is one and the same.*[8]
This *Principle* is analogous to the physical state of a system being described by the *wavefunction ψ* .

Using the above definitions we can derive Basic Law of Physics as mathematical *truisms* [2, 8]:

- *Planck's Formula (*see End Notes*)*
- *The meaning and existence of Planck's constant h*
- *The Quantization of Energy*
- *Conservation of Energy and Momentum*
- *Law of Inertia (*see End Notes*)*
- *Second Law of Motion*
- *Energy-momentum Equivalence*
- *Schrödinger's Equations*
- *Kinetic Energy Formula*
- *Heisenberg's Uncertainty Principle*
- *Boltzmann's Entropy Equation and its Equivalence to Planck's Formula*
- *Entropy-Time Relationship*
- *The Fundamental Thermodynamic Relation*
- *The Second Law of Thermodynamics:* "*Any physical event takes some positive duration of time to occur*"
- *de Broglie Equations* (see End Notes)
- "*If the speed of light is constant, then light propagates as a wave*" (see End Notes)

Summary: We cannot know what is the Universe. Models of the Universe go beyond the physical and so are metaphysical in essence. And all attempts to know what is the Universe ultimately fail. Physics can avoid such fate by limiting its scope to measurements and to mathematical identities (and *not* models) describing measurements and interactions of measurements. The Pythagorean Formula, for example, describes identically the measurements of length for right triangle conditions. While Planck's Formula describes identically the interaction of measurement of energy for blackbody conditions [2, 12]. And QM describes interactions of measurement under more complex conditions. The remarkable convergence of these between experiments and theory argues in favor of this view. Mathematical models, on the other hand, typically diverge and must be fixed to fit.

In my derivation of Planck's Formula [2, 10] the quantity '*eta*' is fundamental. This is the time integral of energy

$$\eta = \int_{t_0}^{t} E(u)du$$ in units of joule-sec. It can be viewed as 'accumulation of energy' and as 'action'. Planck's constant *h*

is such a quantity. And the *wavefunction* describes the distribution of '*eta*' in space and time. Starting with '*eta*' as primary (undefined and undefinable), we can mathematically define physical quantities like energy, momentum, force, entropy and temperature. Planck's constant *h* we show [2, 7] determines the Kelvin temperature scale and is not some mysterious universal 'quantum constant', as currently thought. *(see also Timothy Boyer's essay regarding Planck's constant h)* [39]. Basic Law of Physics, I argue, should be mathematical identities relating measurements of physical quantities. And *not* Universal Law of *what is*. Which I argue is not possible to truly know. And may not even exist in the sense we think.

Following this approach and starting with the quantity '*eta*', we naturally obtain (for blackbody conditions) a proportionality between entropy and time, $\Delta S = k\nu \Delta t$ [2, 6]. From this we discover the change of entropy, *ΔS*, is the '*amount of evolution/devolution*' (depending on the rate constant *ν*) over a duration of time *Δt*. And this suggests the Second Law of Thermodynamics is not really about entropy, but about *time*. It can be restated as, "*every physical process/event takes some positive duration of time to occur*" [2, 6].Thus the Second Law describes the nature of *physical time* as being *duration Δt* and not *instantiation t* as in the Spacetime continuum. This, I argue, may explain the inconsistency between Cosmology and Thermodynamics. An inconsistency that requires a patchwork of phantasmagorical theories to fix. But we can't fix Physics by adding more 'epicycles' to a flawed metaphysical view.

Furthermore and consistent with my approach I am able to prove the following proposition: "*If the speed of light is a constant, then light propagates as a wave*" [2, 18]. Thus, Einstein's CSL Postulate contradicts his Photon Hypothesis. With

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8   Hayrani Oz also uses what he calls *enerxaction* similarly to *eta* [26, 27]

this understanding that light propagates as a wave (and not as a particle projectile) we can now explain why the velocity of light in a medium is constant and independent of the velocity of the source or the observer. Thus, no need in SR to postulate CSL (see also *Peter Jackson* [49], *Israel Omar Perez* [43] *).

I have sketched out in simple terms some broad outlines of a new physical view of Physics. In this view, energy propagates continuously while it interacts discretely. No 'measurement problem' here. Nor 'wave-particle dilemma'. But before 'manifestation of energy' there is an 'accumulation of energy' *eta*. Eric Reiter in his FQXi 2012 essay [50] argues for a similar *loading theory* proposed by Planck and others. But whereas such *loading theory* argues for *continuous absorption and explosive emission,* I believe both absorption and emission, being 'manifestations of energy', are discrete. What in my view is continuous is the 'accumulation of energy' *eta* prior to such 'manifestation of energy'; whether absorption or emission. Such 'accumulation of energy' is below the 'measurement threshold' and so not directly observable. This results in a time delay and a duration of time needed for any physical event to manifest. [9] Manifestation happens when local equilibrium conditions occur while there is an interaction. The *Physical Realism* in this view resolves current paradoxes and brings us back to our senses. *Physics happens at the point of measurement.*

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9   This is consistent with The Second Law of Thermodynamics as restated [2]
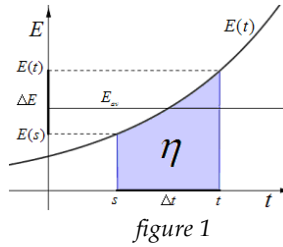
End Notes:

I) Planck's Formula [1], $E_0 = \dfrac{h\nu}{e^{h\nu/kT} - 1}$ **, is an exact mathematical identity that describes the interaction of measurement in ideal blackbody conditions. [2, 10]**

Mathematical Identity:

For any integrable function $E(t)$ *we have the truism,* $\quad \eta = \displaystyle\int_s^{s+\eta/E_{av}} E(u)\,du$

Proof: (see figure 1)

figure 1

Planck's Formula for ideal blackbody conditions (proof – one of several):

Assumptions: 1) Energy locally at the sensor at $t = s$ *can be represented by* $E(s) = E_0 e^{\nu s}$ *, where* E_0 *is the intensity of radiation and* ν *is the frequency of radiation [2, 13]. 2) When measurement is made, the source and the sensor are in equilibrium. The average energy of the source is equal to the average energy at the sensor. Thus,* $\overline{E} = kT$ *. 3) Planck's constant* h *is the minimal 'accumulation of energy' at the sensor that can be manifested or measured. Thus we have* $\eta = h$ *.*

Using the above *Mathematical Identity* and *Assumptions* we have *Planck's Formula*,

$$h = \int_0^{\frac{h}{kT}} E_0 e^{\nu u}\,du = \frac{E_0}{\nu}\left[e^{h\nu/kT} - 1 \right] \text{ and so, } E_0 = \frac{h\nu}{e^{h\nu/kT} - 1} \qquad\qquad \text{q.e.d.}$$

Thus, Planck's Formula is a mathematical truism that describes the interaction of energy. That is to say, it gives a mathematical relationship between the energy locally at the *sensor*, the energy at each cycle absorbed by the *sensor*, and the average energy at the *sensor* during each measurement absorption cycle. Note further that when at a cycle an amount of energy ΔE is absorbed by the *sensor*, $E(t)$ resets to E_0. (see figures 2 and 3)
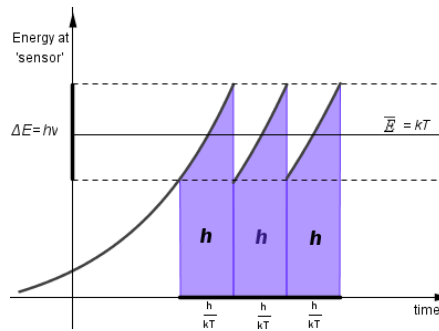

figure 2

figure 3

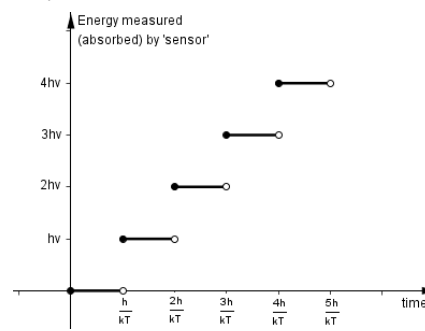## II) The CSL Postulate contradicts the Photon Hypothesis: [2, 18]

The de Broglie Equations derivation [2, 17]: Using the quantity *eta* consider $\eta_0(x_0, t_0) \to \eta(x, t)$.

We can write $\dfrac{\Delta\eta}{\eta_0}$ = %-change of η = 'cycle of change'. For corresponding Δx and Δt we can write,

$\lambda = \dfrac{\Delta x}{\Delta \eta / \eta_0}$ = "distance per cycle of change" and $v = \dfrac{\Delta \eta / \eta_0}{\Delta t}$ = "cycle of change per time". We can rewrite these as

$\lambda = \dfrac{\eta_0}{\Delta \eta / \Delta x}$ and $v = \dfrac{\Delta \eta / \Delta t}{\eta_0}$. Taking limits and letting $\eta_0 = h$ (Planck's constant being the minimal η that can

be measured) we get the *de Broglie equations:*

$$\lambda = \dfrac{\eta_0}{\Delta \eta / \Delta x} \rightarrow \dfrac{h}{\partial \eta / \partial x} = \dfrac{h}{p} \quad \text{and} \quad v = \dfrac{\Delta \eta / \Delta t}{\eta_0} \rightarrow \dfrac{\partial \eta / \partial t}{h} = \dfrac{E}{h}$$

Using the above definitions of λ and v we also have $\lambda v = \Delta x / \Delta t$ = velocity. Also using the quantity *eta,* momentum and energy can be written as [2, 8]

$$p = \dfrac{\partial \eta}{\partial x} \quad \text{and} \quad E = \dfrac{\partial \eta}{\partial t}$$

Note: Since %-change in η can be both positive or negative, λ and v can be any positive or negative real number.

Proposition: "*If the speed of light is constant, then light propagates as a wave*" [2, 18]

Proof: We have that $\lambda = \dfrac{h}{p}$, $v = \dfrac{E}{h}$ and $\lambda v = c$. Since from the above, $\lambda v = \dfrac{\partial \eta / \partial t}{\partial \eta / \partial x}$, differentiating we get

$$D_t(\lambda v) = \dfrac{\dfrac{\partial^2 \eta}{\partial t^2} \cdot \dfrac{\partial \eta}{\partial x} - \dfrac{\partial \eta}{\partial t} \cdot \dfrac{\partial^2 \eta}{\partial t \partial x}}{\left(\dfrac{\partial \eta}{\partial x}\right)^2} \quad \text{and} \quad D_x(\lambda v) = \dfrac{\dfrac{\partial^2 \eta}{\partial x \partial t} \cdot \dfrac{\partial \eta}{\partial x} - \dfrac{\partial \eta}{\partial t} \cdot \dfrac{\partial^2 \eta}{\partial x^2}}{\left(\dfrac{\partial \eta}{\partial x}\right)^2}$$

Since $\lambda v = c$, we have that $D_t(\lambda v) = 0$ and $D_x(\lambda v) = 0$. Therefore,

$$\dfrac{\partial^2 \eta}{\partial t^2} \cdot \dfrac{\partial \eta}{\partial x} - \dfrac{\partial \eta}{\partial t} \cdot \dfrac{\partial^2 \eta}{\partial t \partial x} = 0 \quad \text{and} \quad \dfrac{\partial^2 \eta}{\partial x \partial t} \cdot \dfrac{\partial \eta}{\partial x} - \dfrac{\partial \eta}{\partial t} \cdot \dfrac{\partial^2 \eta}{\partial x^2} = 0$$

Using $\lambda v = \dfrac{\partial \eta / \partial t}{\partial \eta / \partial x}$ and $\lambda v = c$, these can be written as, $\dfrac{\partial^2 \eta}{\partial t^2} = c \cdot \dfrac{\partial^2 \eta}{\partial t \partial x}$ and $\dfrac{\partial^2 \eta}{\partial x \partial t} = c \dfrac{\partial^2 \eta}{\partial x^2}$

Since 'mixed partials are equal', these equations combine to give us,

$$\dfrac{\partial^2 \eta}{\partial t^2} = c^2 \cdot \dfrac{\partial^2 \eta}{\partial x^2} \ ,$$

the wave equation in one dimension. Thus, for the speed of light to be constant the 'propagation of light' η must be a solution to the wave equation. q.e.d

III) Newton's Law of Inertia is a Mathematical *Truism*: "*If the net force is zero, then the velocity is constant*"

Proof: From our definition we have, $F_x = \dfrac{\partial^2 \eta}{\partial x \partial t} = 0$. Integrating twice we get $\eta = a\Delta t$ where *a* is some constant. Since

'mixed partials are equal', integrating again twice but in reverse order we get $\eta = b\Delta x$ where *b* is some constant. By *Identity of Eta*, combining these we get *velocity* $= \Delta x / \Delta t = a/b$ =*constant.* q.e.d.

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