On the Noumenal Realm of Physics

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Abstract

Can we know what is *really* real in physics? More precisely are there synthetic *a priori* propositions to describe the noumenal realm of physics? It will be shown that the answer is 'yes', and this has profound implications for Kant's philosophy as Kant himself believed the noumenal realm is strictly unknowable by us. Now, the classical concept of mass plays a fundamental role in physics even though no one knows what mass *really* is. We shall resolve this fundamental ontological problem by using mass for the final time to reveal the noumenal realm of physics, which is a new paradigm of Relativity. The evolution from classical physics to this mass-free paradigm of Relativity is inevitable with implications for the totality of physics as understood today. Kant's synthetic *a priori* propositions are the unambiguous foundations of this new paradigm. To answer our questions above a knowledge of pre-1925 physics is required and can be found in any standard textbook [1], with the physical arguments already presented in [2] and [3].

Keywords: Noumena, Synthetic *A Priori*, The Light, Equivalence Identity, Bekenstein-Hawking formula, Relativity, Mass, Paradigm

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1. Introduction

By using the classical concept of mass for the final time we shall consistently incorporate Planck's four-dimensional constant into physics proper to reveal at least two synthetic *a priori* foundations of a new paradigm of Relativity. This new paradigm is inevitable and avoids most, if not all, the problems and inconsistencies that beset theoretical physics today. With respect to Kant this is knowledge of the noumenal realm of physics denied by him as even possible.

2. The Light

We begin with the fact that many practical applications of special relativity are found in the theory of relativistic mechanics. The basis of relativistic mechanics are the following four equations

$$M = m_0/\sqrt{1 - (v/c)^2} \qquad (1)$$

which is a function of velocity v where M is the relativistic mass, m_0 the rest mass and c the speed of light in a vacuum. Multiplying both sides of Eq. (1) by the velocity vector $\boldsymbol{v}$ gives us the expression for relativistic momentum

$$\boldsymbol{p} = M\boldsymbol{v} = m_0\boldsymbol{v}/\sqrt{1 - (v/c)^2} \qquad (2)$$

and multiplying both sides of Eq. (1) by c^2 gives the total energy of a particle

$$E = Mc^2 = m_0c^2/\sqrt{1 - (v/c)^2} \qquad (3)$$

Ignoring M in Eqs. (2) and (3) and combining the two equations gives us

$$E = \sqrt{(m_0c^2)^2 + (pc)^2}$$

where we have ignored the negative root, which we shall justify below. Of these four equations only Eqs. (2) and (3) using rest mass are theoretically necessary, and as the basis of relativistic dynamics they are routinely confirmed in elementary-particle physics. Do we just ignore Eq. (1)? No.

We now introduce the energy of a photon $E = hf$ where h is Planck's constant and f is frequency, and equating this with the expression above we get

$$hf = \sqrt{(m_0c^2)^2 + (pc)^2} \qquad (4)$$

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Now, if $m_0 = 0$ in Eq. (4) then using $f = c/\lambda$ we derive de Broglie's hypothesis

$$\lambda = h/p \tag{5}$$

where λ is wavelength, and looking at Eq. (4) once more we find if $p = 0$ we can similarly derive the Compton wavelength

$$\lambda_c = h/m_0 c \tag{6}$$

This much was known before 1925 with the possible exception of the derivation of Eq. (6) as presented here. We now forge a new path by rewriting Eq. (6) in terms of m_0 and substituting for m_0 in Eq. (1) to obtain the expression

$$\lambda = h/M\sqrt{c^2 - v^2} \tag{7}$$

But as M is also a function of velocity v we have

$$\lambda = \frac{h}{\dfrac{m_0\sqrt{c^2 - v^2}}{\sqrt{1 - (v/c)^2}}} \tag{7a}$$

Rather than cancelling terms we observe that if $v = 0$ in Eq. (7a) we get the Compton wavelength. *Reason* now shows us that when $v = 0$ the M used in Eq. (7) corresponds to m_0 in Eq. (7a), which leaves the case of $v > 0$ where the M used in Eq. (7) now corresponds to

$$m_0/\sqrt{1 - (v/c)^2} \tag{\#}$$

in Eq. (7a). Therefore, if Eq. (7a) is the Compton wavelength when $v = 0$, then holding m_0 fixed and *discarding* (#) when $v > 0$ gives us the generalized Compton wavelength

$$\lambda_{GC} = h/m_0\sqrt{c^2 - v^2} \tag{8}$$

Thus all that now remains of Eq. (1) is (#), but suspending judgement on (#) for a moment and rewriting Eq. (8) in terms of m_0 and substituting into Eq. (2) we find a qualitatively different expression where frequency has replaced the concept of rest mass

$$\boldsymbol{p} = hf\boldsymbol{v}/(c^2 - v^2) \tag{9}$$

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To use Eq. (9) we have only to translate rest mass to frequency as follows

$$\boldsymbol{p} = m_0\boldsymbol{v}/\sqrt{1-\ (v/c)^2}$$

$$\lambda_{GC} = h/m_0\sqrt{c^2 - v^2}$$

$$\boldsymbol{p} = hc\boldsymbol{v}/\lambda_{GC}(c^2 - v^2) = hf\boldsymbol{v}/(c^2 - v^2)$$

Excluding Eq. (3), then, leaves (#) as the only expression using rest mass, and since (#) in itself is meaningless it is incumbent upon us to account for its absence. Therefore, starting with Eq. (5)

$$\lambda = h/p$$

and substituting Newton's definition of momentum $p = mv$ for p, we get the basis of wave mechanics or de Broglie equation

$$\lambda = h/mv$$

Substituting (#) for m puts (#) in context giving the relativistic expression

$$\lambda = \frac{h\sqrt{1-(v/c)^2}}{m_0 v} \qquad v > 0$$

Finally, rewriting this expression in terms of m_0 and substituting into the magnitude of Eq. (2) we find

$$p = \frac{hv\sqrt{1-(v/c)^2}}{\lambda v\sqrt{1-(v/c)^2}} = \frac{h}{\lambda}$$

Since we have accounted for the absence of (#), it follows that we have also accounted for the absence of: a) de Broglie's equation, b) Newton's definition of momentum, and c) Eq. (2). Consistency now dictates we substitute Eq. (8) into Eq. (3) and then use the wave vector $\boldsymbol{k}$ where $k = 2\pi/\lambda$, the Dirac constant $\hbar = h/2\pi$, and the angular frequency $\omega = 2\pi f = kc$, giving us

$$\boldsymbol{p} = \hbar\boldsymbol{k}$$
$$E = \hbar\omega c^2/(c^2 - v^2)$$
$$\boldsymbol{p} = \hbar\omega\boldsymbol{v}/(c^2 - v^2) \qquad v > 0$$

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Therefore, the absence of Eq. (2) from physics necessitates the use of these irreducible relations, and thus it is necessary to translate rest mass to angular frequency ω where $\omega = 2\pi c/\lambda_{GC}$.

The basis of relativistic dynamics ($v > 0$) is now consistent with the de Broglie relations ($v = 0$), and the nonexistence of Eq. (2) implies it is these inextricably linked relations rather than Eqs. (2) and (3) that are *really* being routinely confirmed in elementary-particle physics.

Therefore, with respect to Kant the *a priori* knowledge of these synthetic relations was not *unknowable*, but rather as noumena were only unknown. That is, they are not falsifiable as experience is already confirming them unbeknownst to us.

Now, the coining of the term "photon" by Lewis in 1926 is inappropriate as the term refers to the smallest unit of *radiant* energy, but the relations just derived imply the term should be extended to include the energy of *matter* as well. To avoid confusion we shall drop the term "photon" and simply define the Light as the electromagnetic energy and momentum of a particle of *radiation* ($v = 0$), or a particle of *matter* ($v > 0$). Thus the Light shows both *matter* and *radiation* being confirmed in elementary-particle physics.

To be complete we must justify ignoring the negative root in the derivation of

$$E = \pm\sqrt{(m_0c^2)^2 + (pc)^2}$$

The negative root has been associated with *antimatter* in Dirac's equation from 1928, which leaves the question of why we don't observe an equal amount of *antimatter* in the universe? However, looking at the energy expression E in the Light we observe that in the interval $0 < v < c$ E is positive corresponding to *matter*, and in the interval $c < v < c\sqrt{2}$ E is negative, which must correspond to *antimatter*. Now, by special relativity *matter* must be moving at speed c in its own rest frame. We represent this as a point moving up a vertical time axis t starting at an origin O, but with no unit lengths marked such that the distance covered is dimensionless, or a quantity of dimension 1. Rotating the axis around O perpendicularly gives us the time axis $t\,i$ where $i = \sqrt{-1}$ and by symmetry *matter´* moving along this axis at speed c. The relative velocity between *matter* and *matter´* is thus $\sqrt{c^2 + c^2} = c\sqrt{2}$. However, since the energy of *matter´* is in the interval $c < v \leq c\sqrt{2}$ it must be negative, and thus *matter´* is *antimatter*. To show this using special relativity we note that starting at O the number of second's t' passing for *antimatter* relative to the viewpoint of *matter* as we count $t = 1$ second for *matter* is given by the reciprocal of the time-dilation formula with $v = c\sqrt{2}$

$$t' = \sqrt{1 - (2c^2/c^2)} = i$$

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This symmetry holds true irrespective of our choice for a unit of time. Thus, generalising the energy of a photon using the equations of relativistic mechanics gives us the Light

Matter $E_+ = \hbar\omega c^2/(c^2 - v^2)$
$\boldsymbol{p}_+ = \hbar\omega\boldsymbol{v}/(c^2 - v^2)$ $v > 0$

Radiation $E_0 = \hbar\omega$ (de Broglie relations)
$\boldsymbol{p}_0 = \hbar\boldsymbol{k}$

Antimatter $E_- = i\hbar\omega c^2/(c^2 - v^2)$
$\boldsymbol{p}_- = i\hbar\omega\boldsymbol{v}/(c^2 - v^2)$ $v > 0$

The new paradigm of Relativity begins with the Light.

3. Equivalence Identity

Today the Standard Model classifies all known subatomic particles, and 'unifies' electromagnetism, weak, and strong nuclear interactions. The Light entails a fundamental revision of the Standard Model as the Standard Model must be derived anew beginning with the Light in this new paradigm of Relativity. This just leaves the 'force' of gravity.

Newton's second law of motion ($F = ma$) contains all three of Newton's laws of motion, i.e., the third law ($F = -F$); and first law ($F = 0$), or law of inertia. Inertial frames are those in which the law of inertia holds.

In special relativity inertial frames extend throughout all space. In general relativity inertial frames are considered to be freely falling frames moving with neither acceleration nor gravity where the observer experiences weightlessness and tidal forces are considered 'nonlocal'. The problem is that gravity is ubiquitous. But suppose it could be shown *a priori* that $F = ma$ does not exist, then the absence of inertial frames means the observer could not deny that he is in a real gravitational field even though his frame is freely falling. The Light remains unaffected as it is defined in the subatomic realm where the nonuniformity of the gravitational field is negligible and space-time considered flat. However, the absence of inertial frames undermines both special relativity and Maxwell's equations as theories, and would just leave the constant c as encoded in the Light from Maxwell's theory. Simply put "Relativity" would refer to just one theory of relativity where the gravitational field could no longer be ignored in any frame of reference consistent with the fact that the gravitational field *is* ubiquitous.

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Consider, then, that as the derivation of the Light using Eq. (1) also consistently accounts for the absence of $p = mv$ from physics, this in turn implies the absence of Newton's second law, for mathematically we have

$$F = \frac{d(mv)}{dt} = m_I a$$

where F is force, m_I is inertial mass and a is acceleration. We also have

$$W = m_G g$$

where W is the weight of a terrestrial body, m_G is its gravitational mass, and g is the local acceleration of free fall. If we ignore air resistance, then by Galileo's empirical law of falling bodies we put $F = W$ and obtain

$$a = \frac{m_G}{m_I} g$$

General relativity necessitates that Galileo's law be exact such that acceleration is gravity. Now, however, we go beyond Newtonian mechanics, for $m_G = m_I$ mathematically or *a priori* as the Light entails locally there *is* only

$$a = g \qquad \text{(Equivalence Identity)}$$

Therefore, if we assume the gravitational constant, *G*, is used in this new paradigm of Relativity, then all that remains of Newtonian mechanics is *G*. In contrast to general relativity, then, the new paradigm of Relativity stands alone with the constants *G* and *c* our only reminders of the classical physics that was.

Again with respect to Kant the *a priori* knowledge of the Equivalence Identity was not unknowable as it was only the unknown noumenon. As with the Light experience is already confirming it.

Gravity is ubiquitous and cannot be ignored in any frame of reference is not only consistent it also demonstrates the universality and necessity of both the Light and Equivalence Identity in this paradigm.

Up to this point only pre-1925 physics was used, which is historically significant as 1925 saw the avoidable birth of nonrelativistic quantum mechanics. Now we note there is no wave-particle ambiguity in the Light. But even more importantly Relativity *transcends* the classical concept of mass. In retrospect, mass never existed implying its use in *any* theory is misconceived. That is, there is no alternative to Relativity that can give us an understanding of the universe as it *really* is, and thus we have *a priori* knowledge of the noumenal realm of physics.

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Thus far Relativity necessitates a revision of both the Standard Model and general relativity, and that just leaves statistical mechanics and thermodynamics unmentioned. But to be complete we must consistently account for these remaining two classical theories as the nonexistence of Newton's three 'laws' of motion entails a fundamental revision of both.

4. Bekenstein-Hawking formula

Does Relativity subsume these two theories? The following suggests that it does. Consider the Bekenstein-Hawking formula [4] for a black hole

$$S_{BH} = (A/4) \times (kc^3/G\hbar)$$

where k is Boltzman's constant from statistical mechanics, and A is the surface area of the event horizon. If we assume this formula holds true in Relativity, then we have a consistent unification of G, c, $\hbar$, k and *entropy* to remind us of the mass-based paradigm of classical physics that was.

5. Conclusion

Starting with Eq. (1) and $E = hf$ reason shows us that the evolution from classical physics to this mass-free paradigm of Relativity was inevitable, for the nonexistence of mass implies physics proper always *was* this four-dimensional paradigm which consistently incorporates Planck's four-dimensional constant. Relativity is the noumenal realm of physics, and Kant's philosophical rejection of our ability to know it necessitates a revision of his *Transcendental Idealism*.

References

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