Abstract: Albert Einstein's opposition to Quantum Mechanics is well known, as is his attempts to generalise his geometric theory of Gravity and incorporate electromagnetism. Whilst not about Einstein *per se*, this paper will show that Quantum Mechanics could have been avoided, if Einstein had instead used the energy of a *photon* to complete his final geometric theory of Relativity.

Is Relativity the Holy Grail of Physics?

by Robert Spoljaric

The introduction of Planck's four-dimensional constant into Physics represents a break - of sorts - with Classical Physics. However, its use in the various formalisms of non-relativistic Quantum Mechanics is purely arbitrary, based on observation. On the other hand we find neither of Einstein's two theories of Relativity incorporate Planck's constant. As a result Physics is now left with trying to reconcile Quantum Mechanics and General Relativity.

In this brief paper, we use the concept of mass for the final time, to show that the evolution of Physics was towards a single theory of Relativity incorporating Planck's constant. In hindsight, Special Relativity will be seen as not going far enough, and the advent of General Relativity as premature. It will also be clear why the advent of non-relativistic Quantum Mechanics was avoidable. Furthermore, we will find that all that remains of Newtonian Mechanics, and Maxwell's Equations, are the universal constants G and c respectively.

In short, we will discover that behind the 'appearance' of mass lay the necessary foundations for a single geometrical theory of Relativity. Finally, with one additional assumption we include Statistical Mechanics and Thermodynamics, which accounts for the totality of Physics.

Many applications of Special Relativity are found in Relativistic Mechanics. Thus we begin by stating the four equations that are the basis of Relativistic Mechanics:

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

which is a function of velocity v where M is the relativistic mass, m_0 the rest mass and c the speed of light.

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

which is the total energy of a particle; and the relativistic momentum where **v** is the velocity vector

$$\mathbf{p} = M\mathbf{v} = m_0\mathbf{v}/(1- (v/c)^2)^{1/2} \tag{3}$$

The fourth and final (useful) equation forming the basis of Relativistic Mechanics is derived from Eqs. (2) and (3)

$$E^2 = (m_0c^2)^2 + (pc)^2 \tag{4}$$

Of these four equations only Eqs. (2) and (3) are theoretically necessary, and provide the basis for Relativistic Dynamics. They are quantitatively confirmed by their routine use in elementary-particle physics. However, it will be shown that *qualitatively* they are fictitious.

To demonstrate this last statement, and resolve the apparent arbitrariness of Relativistic Mechanics, requires the energy of a *photon*

$$E = hf$$

where h is Planck's constant and f is frequency.

We begin by taking the square root of both sides of Eq. (4), to obtain

$$E = \pm((m_0c^2)^2+(pc)^2)^{1/2} \qquad \text{Eq. (4a)}$$

Classical Physics ignores the negative root - consistent with our everyday experience of the world. (The same is not true of modern physics, which erroneously associates the negative root with antimatter, but then cannot explain its general absence – see later.) Thus we equate

$$hf = ((m_0c^2)^2+(pc)^2)^{1/2} \qquad (5)$$

For a 'particle of light,' let $m_0=0$ in Eq. (5) and using $f=1/T$ and $Tc=\lambda$ where T is periodic time and λ is the wavelength, we derive the de Broglie hypothesis

$$\lambda = h/p$$

To be thorough we must also consider the 'rest-energy of matter,' and let p=0 in Eq. (5) to similarly derive the Compton wavelength

$$\lambda = h/m_0c$$

These two wavelengths are not new. However, rewriting the Compton wavelength in terms of m_0 and substituting for m_0 in Eq. (1), we obtain the *generalised* Compton wavelength

$$\lambda = h/M(c^2-v^2)^{1/2}$$

Consistency with the Compton wavelength implies that if v=0 then $M=m_0$, which just leaves $m_0/(1-(v/c)^2)^{1/2}$ from Eq. (1). And rewriting the generalised Compton wavelength in terms of m_0 and substituting for m_0 in Eqs. (2) and (3), gives us

$$E = hc^3/\lambda(c^2-v^2) = hfc^2/(c^2-v^2)$$
$$\mathbf{p} = hc\mathbf{v}/\lambda(c^2-v^2) = hf\mathbf{v}/(c^2-v^2)$$

Finally, given the wave vector **k** where $k=2\pi/\lambda$, the Dirac constant $\hbar=h/2\pi$, and the angular frequency $\omega=2\pi f=kc$, we derive *a priori* the irreducible synthetic relations

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

Therefore, when v=0 we have the Planck-Einstein relations, and when v>0 the expressions E and **p** correspond *quantitatively* to their non-existent classical counterparts, Eqs. (2) and (3) respectively. Thus we discard the classical 'wave' theory of light when v=0, and the classical 'mass-based' particle theory of matter when v>0. Clearly 'classical wave/classical particle' duality is meaningless.

The deterministic relations are the counterexample to Quantum Mechanics (see later), and hence Einstein's intuition to reject Quantum Mechanics *was* correct!

According to Special Relativity since *matter* is without 'mass' it must move at speed *c*. Hence *matter* at rest, relative to an observer *O*, is moving at speed *c*? Before resolving this seeming contradiction, we note that pair creation/destruction demonstrates the existence of *antimatter*, and thus by symmetry it too must be moving at speed *c*. Thus, if the relations are to be consistent with Special Relativity (and resolve the seeming contradiction above), then the relative velocity between *matter* and *antimatter* must equal $c(2)^{1/2}$ (Pythagoras' Theorem, $(c^2+c^2)^{1/2} = c(2)^{1/2}$). For now if we introduce two mutually perpendicular time axes t and *i*t, where $i=(-1)^{1/2}$, we consistently find that the number of seconds t′ passing for *antimatter*, relative to the viewpoint of the observer *O*, as the observer counts one second passing for *matter*, is given by the reciprocal of the time-dilation formula with $v=c(2)^{1/2}$

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

Furthermore if the velocity of E is in the range $c<v<c(2)^{1/2}$ then we have negative energy, and hence associating the negative root of Eq. (4a) with *antimatter* is meaningless. So, consistent with both Special Relativity, and the general absence of *antimatter*, is a necessary hidden symmetry between *matter* and *antimatter*, which theoretically implies a separate 'mirror' Universe of *antimatter*.

From Relativistic Mechanics only $m_0/(1-(v/c)^2)^{1/2}$ remains, and so we summarise as follows: Using the 'appearance' of rest mass for the final time, we discover a relativistic *particle* theory of Light in the subatomic realm

$$E = m_0c^2/(1- (v/c)^2)^{1/2}$$
$$\mathbf{p} = m_0\mathbf{v}/(1- (v/c)^2)^{1/2} \qquad v>0$$

$$\lambda = h/m_0(c^2-v^2)^{1/2} \qquad \text{(generalised Compton wavelength)}$$

Matter

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

Radiation

$$E_0 = \hbar\omega \qquad \text{(Planck-Einstein relations)}$$
$$\mathbf{p}_0 = \hbar\mathbf{k}$$

Antimatter

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

As a non-arbitrary 'thing-in-itself,' the relativistic hyper-dimensional Light supersedes Special Relativity in the subatomic realm, and is the *real* basis for Relativistic Dynamics. (A *meaningful* expression similar to Eq. (4) does not follow from these relations.) Furthermore the Light demonstrates the following:

1) All that remains of Maxwell's (apparent wave) Equations is the constant *c*.
2) The Light surpasses Newtonian Mechanics by transcending Newton's ephemeral concept of mass. (The Gravitational constant, *G*, is accounted for below.)
3) As the Light necessarily incorporates *ħ*, every *arbitrary* 'mass-based' formalism of *non*-relativistic Quantum Mechanics is fictitious, and could have been avoided.
4) The Light renders Einstein's 'mass-based' theory of General Relativity premature.

Now, General Relativity begins with Einstein's deduction of the Equivalence Principle, and his theory succeeds in unifying both *G* and *c*. The problem is that in deducing the principle Einstein (unrealistically) ignored the non-uniformity of Gravity. Given the Light, however, we will take the final step and derive *a priori* the Equivalence *Identity*, which will leave only free falling frames of reference subject to Gravity's non-uniformity.

Firstly, the Newtonian definition p=mv disappears of its own accord, given the de Broglie equation. Using $\lambda=h/p$ de Broglie assumes

$$\lambda = h/mv$$

which is generalised by replacing m with $m_0/(1-(v/c)^2)^{1/2}$ to give

$$\lambda = h(1-(v/c)^2)^{1/2}/m_0v$$

But now rewriting this generalisation in terms of m_0 and substituting for m_0 in the magnitude of Eq. (3), we discover

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

Thus the same holds true for Newton's Second Law - since differentiating Newton's definition of momentum with respect to time t, gives us

$$F = d(mv)/dt = m_Ia$$

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

$$W = m_Gg$$

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

$$a = (m_G/m_I)g$$

Finally, $m_G=m_I$ *a priori* as the Light entails locally there *is* only

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

Thus the absence of Newton's Second Law means there are *no* Newtonian Laws of Motion, that is, there is no First Law F=0, and no Third Law F=-F. Therefore inertial frames are fictitious, which leaves just free falling frames under the influence of non-uniform Gravity. By analogy with General Relativity, then, the Equivalence Identity leaves only the 'curvature' of space-time to explain Gravity, which implies the relativistic unification of the constant *G* with *c* and $\hbar$. Thus we discard the qualifiers "special" and "general," for behind the 'appearance' of mass lay the necessary irreducible foundations for a single geometrical theory of Relativity.

Unlike Quantum Mechanics, we are now able to differentiate between the *real*, and the *apparent.* For example, the de Broglie equation was meaningless as a basis for Schrödinger's (fictitious) Wave Equation. Moreover, the Davisson-Germer experiment can *only* 'falsify' the generalised Compton wavelength - as its velocity is in the range $0\leq v<c$, which mutually excludes de Broglie's equation. But the generalised Compton wavelength is only *apparent* –

being nothing more than a necessary step in deriving the real basis of Relativistic Dynamics. Thus, whilst the generalised Compton wavelength is *quantitatively* 'non-falsifiable,' the *real* explanation for the phenomena begins with the Light.

Does Relativity subsume the two remaining Classical theories of Statistical Mechanics and Thermodynamics, given the absence of Newton's 'Laws' of Motion? Consider the thermodynamic *entropy* of a Black-hole, as given by the Bekenstein-Hawking formula

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

where k is Boltzman's constant from Statistical Mechanics, and A is the surface area of the event horizon. If we assume the formula holds true for 'massless' Black-holes, then we have a consistent (non-classical) relativistic unification of both the constants G, c, $\hbar$, k and *entropy*.

In conclusion, if the assumption above is correct, and the propositions correlating with our sense experiences have yet to be derived, then all that remains of Classical Physics are the constants G, c, k, and the concept of *entropy*. Hence Physics has progressed from Classical Physics to a final theory of Relativity.

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