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The October Postulates: The de Broglie wave-particle dualism in general relativity

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The conventional de Broglie postulates, the basis of wave-particle dualism, are extended to general relativity using one additional postulate that relates mass to scalar curvature. The three postulates together are named 'The October Postulates' to distinguish them from the original de Broglie postulates of 1922 to 1924. In UFT 158 to 160 of this series it was shown that the Compton effect could not be described by the de Broglie postulates, catalysing a crisis in natural philosophy. In this paper it is shown that the Compton effect can be described with the use of the scalar curvature R defined in the ECE wave equation.

Keywords: October Postulates, ECE theory, Compton effect, de Broglie wave-particle dualism.

1. Introduction

The two wave-particle dualism equations of Louis de Broglie [1, 2] are well known to be the basis of relativistic quantum mechanics. They are embodied in the operator relations of quantum mechanics which elegantly transform the Einstein energy equation of special relativity to the Dirac equation. The latter has recently been extended to general relativity and unified field theory using the well known ECE wave equation [3–12]. In UFT 158 to 160 of this series it was shown that the de Broglie postulates cannot explain the Compton effect, thus catalysing a major crisis in natural philosophy. In this paper it is shown that the curvature R can be used to provide an explanation for the results of UFT 158 to 160, results which showed that the mass of the photon and electron varied considerably in different scattering experiments of the Compton effect. In Section 2, the two de Broglie postulates are used with the addition of a single new hypothesis which relates the apparently varying mass of UFT 158 to 160 to R of the ECE wave equation. The three postulates together are named 'The October Postulates' to distinguish them from the original de Broglie postulates

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[1, 2] of 1922 to 1924. The general theory of the Compton effect is extended for use with R and the conditions defined under which the theory reduces to that conventionally used to describe experimental data from the scattering of photons from electrons, the original Compton effect.

2. The October Postulates and general Compton scattering

Consider the tetrad postulate of Cartan geometry [13, 14]:

$$D_\mu q_\nu^a = \partial_\mu q_\nu^a + \omega_{\mu\nu}^a - \Gamma_{\mu\nu}^a = 0 \tag{1}$$

where q_ν^a is the Cartan tetrad, where $\omega_{\mu\nu}^a$ is defined by:

$$\omega_{\mu\nu}^a = \omega_{\mu b}^a q_\nu^b \tag{2}$$

and where $\Gamma_{\mu\nu}^a$ is defined by:

$$\Gamma_{\mu\nu}^a = \Gamma_{\mu\nu}^\kappa q_\kappa^a . \tag{3}$$

Here $\omega_{\mu\nu}^a$ is the Cartan spin connection and $\Gamma_{\mu\nu}^\kappa$ the connection of geometry in a spacetime with torsion and curvature. The tetrad postulate for n-dimensional space is then:

$$\partial_\mu q_\nu^a = \Gamma_{\mu\nu}^a - \omega_{\mu\nu}^a , \tag{4}$$

and implies that the vector field is independent of the coordinate system with which it is defined. This is the most fundamental property of differential geometry. Operate on both sides of Eq. (4) by the contravariant partial derivative ∂^μ to obtain:

$$\partial^\mu \partial_\mu q_\nu^a = \Box q_\nu^a = \partial^\mu \left(\Gamma_{\mu\nu}^a - \omega_{\mu\nu}^a \right). \tag{5}$$

Finally, define the scalar curvature R by:

$$R q_\nu^a := \partial^\mu \left(\omega_{\mu\nu}^a - \Gamma_{\mu\nu}^a \right) \tag{6}$$

to obtain the ECE wave equation that unifies quantum mechanics and general relativity:

$$\left(\Box + R \right) q_\nu^a = 0 \tag{7}$$

where R is defined by:

$$R = q_a^{\nu} \partial^{\mu} \left(\omega^a_{\mu\nu} - \Gamma^a_{\mu\nu} \right). \tag{8}$$

The wave equation (7) reduces to the wave format of the Dirac equation [3–12] in the limit:

$$R_0 = \left(\frac{m_0 c}{\hbar} \right)^2 \tag{9}$$

where m_0 is the mass of the fermion, $\hbar$ is the reduced Planck constant and c is the speed of light. The wave equation (7) reduces to the Proca equation for the boson with mass m_0 in the same limit (9). The classical limit of the Dirac equation is the Einstein energy equation of special relativity:

$$p^{\mu} p_{\mu} = m^2 c^2 \tag{10}$$

which can be written out as:

$$E^2 = c^2 p^2 + m^2 c^4. \tag{11}$$

Here E is the total energy, p is the linear momentum, and m the mass of an elementary particle. The Einstein energy equation is therefore generalized by the use of R to a wave equation of quantum mechanics in general relativity and unified field theory.

The wave-particle dualism of de Broglie is expressed as the equations [1, 2]:

$$\mathrm{E} = \hbar\, \omega = \gamma m c^2 \tag{12}$$

$$\boldsymbol{p} = \hbar\, \boldsymbol{\kappa} = \gamma\, m \boldsymbol{v}, \tag{13}$$

where the Lorentz factor is:

$$\gamma = \left(1 - \frac{v^2}{c^2} \right)^{-1/2}. \tag{14}$$

Here E is the total relativistic energy and $\boldsymbol{p}$ is the relativistic momentum. In Eqs. (12) and (13) the angular frequency of waves is ω in radians per second, and the wave vector is $\boldsymbol{\kappa}$. The wave is in general a matter wave, so Eqs. (12) and (13) are in one sense an expression of unified field theory, in that electromagnetism and matter are put on the same footing. All material matter has duality, in that it is at the same time particulate and ondulatory. In the notation of four vectors the wave-particle dualism is:

$$p^\mu = \hbar \, \kappa^\mu \tag{15}$$

where:

$$p^\mu = \left(\frac{E}{c}, \boldsymbol{p} \right) \tag{16}$$

and where:

$$\kappa^\mu = \left(\frac{\omega}{c}, \boldsymbol{\kappa} \right), \tag{17}$$

and is the direct precursor of the wave equations of quantum mechanics through the operator relations:

$$p^\mu = i \, \hbar \, \partial^\mu \tag{18}$$

which in vector notation become:

$$E = i \, \hbar \frac{\partial}{\partial t}, \;\; \boldsymbol{p} = -i \hbar \nabla. \tag{19}$$

In UFT 158 to UFT 160 of this series [3–12] it was shown that the de Broglie postulates do not describe the Compton effect [15, 16] self consistently. This is a crisis for natural philosophy because it was thought that the Compton effect was the experimental basis of quantum mechanics. When a particle of mass *m* is scattered at ninety degrees from a second particle of mass m the de Broglie postulates produce the result:

$$m \, c^2 / \hbar = \omega' + \omega'' - \omega, \tag{20}$$

$$\left(m \, c^2 / \hbar \right)^2 = \omega^2 + \omega'^2 - \omega''^2, \tag{21}$$

from energy and momentum conservation respectively. Here ω is the angular frequency of the incoming wave, ω' is the scattered angular frequency of that wave, and ω'' is the scattered angular frequency of the initially stationary target particle. Equations (20) and (21) mean that:

$$\omega'' = \omega \tag{22}$$

and

$$m = \frac{\hbar \omega'}{c^2}. \tag{23}$$

The mass m varies in general, because it is proportional to ω'. This means that an additional hypothesis is needed to make the de Broglie postulates self consistent.

This hypothesis is as follows:

$$\left(\frac{m}{m_0}\right)^2 = \frac{R}{R_0} \tag{24}$$

where m_0 denotes the mass of the elementary particle as measured in the standards laboratories. The curvature R_0 denotes that of the Dirac equation:

$$R_0 = \left(\frac{m_0 c}{\hbar}\right)^2 . \tag{25}$$

The three postulates (12), (13) and (24) are denoted 'The October Postulates' to distinguish them from the two de Broglie postulates (12) and (13). The third postulate (24) means that R is defined as:

$$R = \left(\frac{mc}{\hbar}\right)^2 . \tag{26}$$

For ninety degree equal mass scattering it follows that:

$$R = R_0 = \left(\frac{\hbar\omega'}{mc^2}\right)^2 = q_a^{\nu}\partial^{\mu}\left(\omega^a_{\mu\nu} - \Gamma^a_{\mu\nu}\right), \tag{27}$$

and that in this case R is directly proportional to ω'^2 while m_0 remains constant.

In the more general case of the scattering of a particle of mass m_1 from one of mass m_2 at a scattering angle θ, it was found in UFT 159 and 160 that: the de Broglie postulates (12) and (13) give the result:

$$x_2 = \frac{\omega\omega'}{\omega - \omega'} - \left(\frac{x_1^2}{\omega - \omega'} + \frac{1}{\omega - \omega'}\left(\omega^2 - x_1^2\right)^{1/2}\left(\omega^2 - x_1^2\right)^{1/2}\cos\theta\right) \tag{28}$$

where

$$x_1 = \frac{m_1 c^2}{\hbar}, \quad x_2 = \frac{m_2 c^2}{\hbar}. \tag{29}$$

In this case the scalar curvature R is:

$$R = \left(\frac{m_2 c}{\hbar}\right)^2 = \frac{1}{c^2}\left(\frac{\omega\omega'}{\omega - \omega'} - \left(\frac{x_1^2}{\omega - \omega'} + \frac{1}{\omega - \omega'}\left(\omega^2 - x_1^2\right)^{1/2}\left(\omega^2 - x_1^2\right)^{1/2}\cos\theta\right)\right)^2 \tag{30}$$

and is not a constant.

The usual textbook [15, 16] equation of the Compton effect applies only in the limit:

$$x_1 = 0, \tag{31}$$

and is:

$$\frac{1}{\omega'} - \frac{1}{\omega} = \frac{1}{cR_0^{1/2}}\left(1 - \cos\theta\right). \tag{32}$$

The limit (31) is appropriate only for the small mass of the photon, or when it is arranged experimentally that:

$$x_1 \ll x_2. \tag{33}$$

From the hypothesis (24) the varying masses m_1 and m_2 in Eq. (28) are replaced by their associated curvatures as follows:

$$m_1^2 = m_{10}^2 \frac{R_1}{R_0}, \quad m_2^2 = m_{20}^2 \frac{R_1}{R_0} \tag{34}$$

where m_{10} and m_{20} are the constant laboratory measured masses of the particles. For example, in electron Compton scattering m_{10} is the mass of the electron, known to a relative uncertainty of about 10^{-8}. The converse of Eq. (28) is its solution for m_1 in terms of m_2:

$$x_1^2 = \frac{1}{2a}\left(-\mathrm{b} \pm \left(\mathrm{b}^2 - 4\mathrm{ac}'\right)^{1/2}\right. \tag{35}$$

where:

$$\left.\begin{aligned} &\mathrm{a} = 1 - \cos^2\theta, \\ &\mathrm{b} = \left(\omega'^2 + \omega^2\right)\cos^2\theta - 2\mathrm{A}, \\ &\mathrm{c}' = \mathrm{A}^2 - \omega^2\omega'^2\cos^2\theta, \\ &\mathrm{A} = \left(\omega\omega' - x_2\right)\left(\omega - \omega'\right). \end{aligned}\right\} \tag{36}$$

In the limit:

$$x_1 = 0 \tag{37}$$

$$\mathrm{b}^2 - 4\mathrm{ac}' = \mathrm{b}^2 \tag{38}$$

so

$$4\mathrm{ac}' = 0 \tag{39}$$

whose relevant solution is:

$$c' = 0 \tag{40}$$

i.e.

$$(\omega\omega' - x_2)(\omega - \omega') = \omega\omega' \cos\theta \tag{41}$$

or

$$x_2 = \frac{\omega\omega'}{\omega - \omega'}(1 - \cos\theta) \tag{42}$$

which is Eq. (32) again. Data on Compton scattering prior to UFT 158 to 160 were always used with Eq. (32) or (42). This was a mirage that persisted for almost ninety years.

The three postulates:

$$\left.\begin{aligned} E &= \hbar\,\omega = \gamma\, m\, c^2 \\ \boldsymbol{p} &= \hbar\,\boldsymbol{\kappa} = \gamma\, m\, \boldsymbol{v} \\ \left(\frac{m}{m_0}\right)^2 &= \frac{R}{R_0} \end{aligned}\right\} \tag{43}$$

are the October Postulates, which save the de Broglie postulates in the theory of Compton scattering.

3. Least squares fit of mass parameters

In UFT papers 158–160 (see the present issue of the journal), it was shown by numerical evaluation that for Compton scattering experiments the momentum conservation leads to inconsistent values of masses. This is either the photon mass or the mass of the collision partner, an electron. The problem can only be remedied by introduction of new concepts, for example scalar curvature of general relativity. In the numerical work one of the masses was assumed to have the experimentally known value and the other was obtained by evaluating Eq. (28). In this paper we try to evaluate both masses m_1 and m_2 simultaneously. From this attempt precise results cannot be expected, therefore we chose the method of least squares fitting to obtain both mass values (more precisely: x_1 and x_2) from Eq. (28). The input parameters are ω, ω' and θ. Each single experiment referenced in UFT 158 was taken as a data set, and x_1 and x_2 were obtained from the numerical fitting procedure. If the results are reasonable, the condition

$$x_1 \ll x_2 \tag{44}$$

should be fulfilled. We used a least squares routine from computer algebra which allows inputting the fitting formula in symbolic form. It was however not possible to define further constraints like Eq. (44). In order to avoid division by zero, Eq. (28) had to be rewritten in squared form:

$$\left((\omega-\omega')x_2+x_1^2-\omega\omega'\right)^2=\cos^2\theta\left(x_1^4-\left(\omega^2+\omega'^2\right)x_1^2+\omega^2\omega'^2\right). \tag{45}$$

The results for m_1 and m_2 are listed in Table 1. There are 10 data sets in total. In order to see the variance of the result we used a different number of data sets to do the least squares fit, ranging from 2 to 10. We used atomic units so that we expect m_2=1 for the electron mass. Obviously the results vary strongly with the data sets, and condition (44) is not fulfilled in any case. We conclude that variation of both mass parameters does not lead to a meaningful result and de Broglie–Einstein theory is refuted once more.

Table 1. Values of m_1 and m_2 from least squares fit for different number of data sets

No. of data sets	m_1 (a.u.)	m_2 (a.u.)
2	0.941	0.435
3	0.841	0.551
4	0.755	0.632
5	0.741	0.643
6	0.744	0.641
7	0.737	0.645
8	0.721	0.655
9	0.698	0.670
10	0.375	0.876

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