# Development of the covariant mass ratio into spectra of general utility

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The concept of covariant mass ratio of the Einstein–Cartan–Evans (ECE) theory is developed into spectra which can be used in analytical laboratories and throughout physics and chemistry in many different experiments, for example in scattering and absorption theory. The new type of spectrum is characteristic of all types of scattering process, and is exemplified by ninety degree scattering and the original Compton effect. Using the latter a new fundamental spectrum is inferred.

*Keywords*: ECE theory, covariant mass ratio, *R* spectra, scattering theory, Compton scattering.

## 1. Introduction

During the development of ECE theory [1–12] the major discovery has been made recently that the de Broglie–Einstein equations [13, 14] become severely self-inconsistent when conservation of linear momentum and conservation of energy are correctly considered. Some essays and talks explaining the importance of this discovery are available on www.aias.us. The original de Broglie postulates [13, 14] have been augmented by the introduction of the covariant mass ratio. In Section 2, this concept is worked into the de Broglie Einstein equations to give two equations involving the *R* parameter of ECE theory, essentially the most fundamental entity of Cartans differential geometry. The utility of these equations is illustrated with ninety degree scattering and the original Compton effect, in which the equations give a new interpretation in terms of an *R* spectrum or covariant mass spectrum. In general terms the latter is shown to be of utility throughout physics and chemistry in areas such as scattering theory and absorption theory. In Section 3 some types of spectra are illustrated using experimental data.

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## 2. de Broglie Einstein equations in ECE theory and R spectra

The de Broglie Einstein equations [13,14] are as follows:

$$E = \gamma m_0 c^2 = \hbar \omega \tag{1}$$

and

$$\boldsymbol{p} = \gamma m_0 \boldsymbol{v} = \hbar \boldsymbol{\kappa} \tag{2}$$

where $E$ is the total relativistic energy of special relativity and $\boldsymbol{p}$ is the relativistic momentum. The Lorentz factor is defined by the well known:

$$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} \tag{3}$$

where $v$ is the linear velocity of a particle in the frame of the observer. The mass $m$ that appears in these equations in the context of special relativity is the mass as usually given in standards laboratory data or tables of particle masses. In these equations $\omega$ is the angular frequency of matter, and $\boldsymbol{\kappa}$ the wave vector of matter. The equations mean that any kind of matter exhibits wave particle dualism. In recent papers (UFT 158 to UFT 163 on www.aias.us) the $m_0$ of special relativity has been referred to as the rest mass. The reason for this appellation is that mass in ECE theory is defined by the equation:

$$R = \left(\frac{mc}{\hbar}\right)^2 \tag{4}$$

where $R$ is the parameter of the ECE equation, $c$ is a constant, the maximum velocity attainable, and $\hbar$ is the reduced Planck constant. The concept of mass as appears in Eq. (4) is geometrical in origin, $R$ being defined as in UFT 158 to UFT 163 in terms of the tetrad, gamma connection and spin connection of the differential geometry of Cartan. Therefore there are two fundamental equations in which appear $R$:

$$\omega = \gamma R^{1/2} c, \ \boldsymbol{\kappa} = \gamma R^{1/2} \frac{v}{c}. \tag{5}$$

These equations generalize scattering and absorption theory for example. If we consider the scattering of a particle with ECE parameter $R_1$ from an initially stationary particle of ECE parameter $R_2$, conservation of energy is expressed as:

$$\omega + \omega_0 = \omega' + \omega'' \tag{6}$$

Here $\omega$ is the initial angular frequency of the incoming matter wave, $\omega_0$ is the rest frequency of the particle initially at rest, $\omega'$ is the scattered angular frequency associated with $\omega$, and $\omega''$ is the scattered angular frequency associated with $\omega_0$. Conservation of momentum is represented by the wave vector equation:

$$\kappa = \kappa' + \kappa'' \tag{7}$$

Using the methods developed in UFT 158 to 163 (www.aias.us), Eqs. (6) and (7) can be solved simultaneously to give:

$$\mathrm{A} = \omega\omega' - c R_2^{1/2}\left(\omega - \omega'\right) = R_1 c^2 + \left(\omega^2 - R_1 c^2\right)^{1/2}\left(\omega'^2 - R_1 c^2\right)^{1/2}\cos\theta. \tag{8}$$

In general, $R_1$ and $R_2$ are not constant, they are new types of spectra of utility in analytical laboratories.

This fact is illustrated firstly with the original Compton experiment, in which:

$$R_1 = 0 \tag{9}$$

by definition. In this case:

$$\mathrm{A} = \omega\omega' - c R_2^{1/2}\left(\omega - \omega'\right) = \omega\omega'\cos\theta. \tag{10}$$

which is the equation:

$$\frac{1}{\omega'} - \frac{1}{\omega} = \frac{1}{c R_2^{1/2}}\left(1 - \cos\theta\right). \tag{11}$$

This means that experiments on the Compton effect give the result:

$$\mathrm{A} = \omega\omega'\cos\theta. \tag{12}$$

The general solution of Eq. (8) is (UFT 158 to UFT 163):

$$\begin{aligned}
R_1 c^2 &= \frac{1}{2a}\left(-\mathrm{b} \pm \left(\mathrm{b}^2 - 4\,a\,\mathrm{c}'\right)^{1/2}\right) \\
a &= 1 - \cos^2\theta, \\
\mathrm{b} &= \left(\omega^2 + \omega'^2\right)\cos^2\theta - 2\mathrm{A}, \\
\mathrm{c}' &= \mathrm{A}^2 - \omega^2\omega'^2\cos^2\theta, \\
\mathrm{A} &= \omega\omega' - c R_2^{1/2}\left(\omega - \omega'\right).
\end{aligned} \tag{13}$$

Equation (12) means that in the general solution (13):

$$c' = 0. \tag{14}$$

The usual solution for the Compton effect (the 'massless photon' solution) is given by the choice:

$$R_1 = \frac{1}{2ac^2}\left(-b + b\right) = 0 \tag{15}$$

in Eq. (13). However, there exists a hitherto unknown solution given by the other root:

$$R_1 = -\frac{b}{ac^2}. \tag{16}$$

This solution is the $R_1$ spectrum of ECE theory:

$$R_1\left(\omega, \omega', \theta\right) = -\frac{b}{ac^2} \tag{17}$$

where:

$$b = \left(\omega^2 + \omega'^2\right)\cos^2\theta \; - \; 2\omega\,\omega'\cos\theta, \; a = 1 - \cos^2\theta \tag{18}$$

This means that the ECE parameter $R_1$ is a new photon property and a new type of spectrum that depends on ω, ω', and θ. These are all experimental observables so the spectrum is a property of the material from which Compton scattering occurs. It can be used in analytical laboratories to give a fingerprint of that material. There is no a priori restriction on $R_1$, it can be positive, negative, complex or pure imaginary. As usual in physics the physical value of a complex $R_1$ is defined as the real valued square root of the conjugate product

$$R_1 = \left(R_1 R_1^*\right)^{1/2} \tag{19}$$

For ninety years the Compton effect experiment has been interpreted solely in terms of the solution

$$R_1 = 0 \tag{20}$$

which in the incorrect dogma of the standard model signifies the 'massless photon'.

Equation (8) can be rewritten as:

$$c R_2^{1/2} = \frac{\omega\omega'}{\omega-\omega'} - \left( \frac{c R_1^2}{\omega-\omega'} + \frac{1}{\omega-\omega'} \left(\omega^2 - c R_1^2\right)^{1/2} \left(\omega^2 - c R_1^2\right)^{1/2} \cos\theta \right) \tag{21}$$

and for scattering at ninety degrees of a particle of any $R_1$ from another of any $R_2$:

$$\omega' = \frac{\omega x_2 + x_1^2}{\omega + x_2} \tag{22}$$

where:

$$x_1 = c R_1^{1/2},\ x_2 = c R_2^{1/2}. \tag{23}$$

Therefore, the ratio of $R$ parameters is:

$$\frac{R_1}{R_2} = \frac{1}{\omega_0^2}\left(\omega\omega' - \omega_0\left(\omega-\omega'\right)\right) \tag{24}$$

This ratio reduces to zero if:

$$\omega\omega' = \omega_0\left(\omega-\omega'\right) \tag{25}$$

i.e. if:

$$\frac{1}{\omega'} - \frac{1}{\omega} = \frac{1}{\omega_0} \tag{26}$$

If $R_2$ is defined in terms of the constant rest mass $m_{20}$:

$$R_2 = \left(\frac{m_{20}c}{\hbar}\right)^2.$$

Eqution (26) is the textbook equation of the Compton effect at ninety degrees. It is seen that when:

$$\frac{R_1}{R_2} = \frac{1}{\omega_0^2}\left(\omega\omega' - \omega_0\left(\omega-\omega'\right)\right) \neq 0 \tag{28}$$

the ratio $R_1/R_2$ generalizes the usual interpretation. This generalization became dramatically necessary in UFT 158 to UFT 163 because it was found that the usual interpretation in terms of constant masses failed, the masses in general vary, thus refuting the standard model completely.

Most generally, the $R_1$ spectrum is found from Eq. (21). If one of the particles is initially static, the $R_2$ parameter is constant, and defined by the rest mass:

$$R_2 = \left(\omega_0 / c\right)^2 \tag{29}$$

so $R_1$ provides a spectrum that is very useful for analysis of any material from which scattering occurs, or which can be used in general in any type of scattering experiment. The systematic development of these concepts will be the subject of future work.

## 3. Illustrations of *R* spectra from experimental data

The ratio $R_1/R_2$ can be derived from experimental spectra. $R_1$ is defined by Eq. (13), $R_2$ for an initially static particle is given by Eq. (29). We show an example for methane given in [15]. The electron mass is

$$m_1 = 9.10953 \times 10^{-31} \text{ kg} \tag{30}$$

and the mass of the carbon atom of methane (scattering target) is

$$m_2 = 1.99 \times 10^{-26} \text{ kg}, \tag{31}$$

leading to a de Broglie frequency of

$$\omega_0 = 1.69594 \times 10^{25} \text{ /s}. \tag{32}$$

The results for $R_1/R_2$ with both solutions of (13) are shown in Fig. 1. Both values of $R_1$ are real valued and negative, therefore we can omit the complex averaging of Eq. (19). Both curves in Fig. 1 refer to the same 2D points ($\omega'$, $\theta$) in the base plane. Therefore both curves coincide when viewed from a direction parallel to the $Z$ axis.

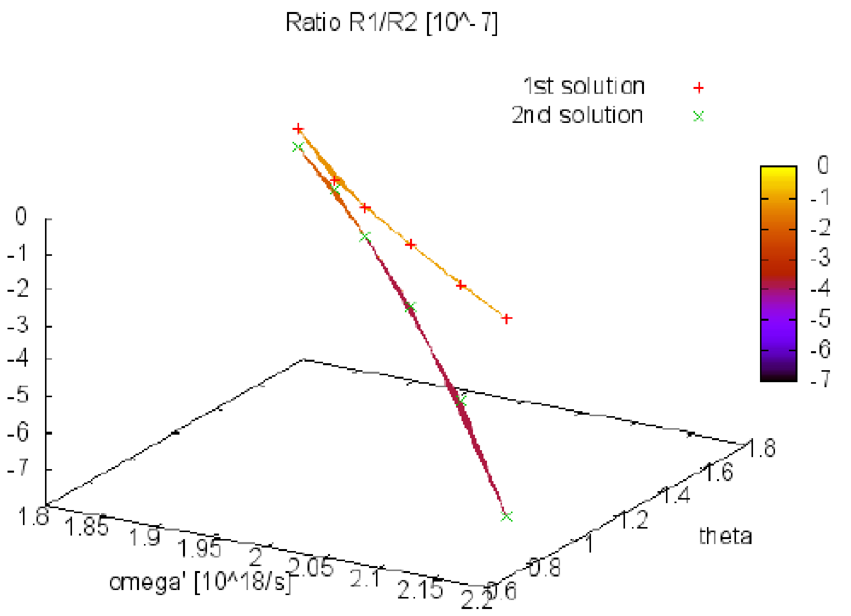


**Fig 1.** Ratio of R parameters R1/R2 for experimental Compton scattering data from [15].

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