

Criticisms of the theory of absorption and Raman scattering

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Simple considerations of conservation of linear momentum show that the theory of atomic and molecular absorption, and that of Raman scattering, become hopelessly untenable even within the context of the standard model, its use of the hypothetically massless photon. It is shown that the simplistic theory of absorption due to Einstein collapses due to neglect of conservation of linear momentum. The latter generalizes the theory of absorption based on the photon's spin angular momentum. A suggestion for improvement is made based on the ECE theory of covariant mass.

Keywords: Atomic and molecular absorption, Raman scattering, conservation of linear momentum, ECE unified field theory.

1. Introduction

In UFT 158 to 161 of this series of one hundred and sixty one papers to date [1–12] it has been shown that the theory of Compton scattering becomes hopelessly self inconsistent once conservation of momentum is considered properly. In this paper the same conclusion is shown to hold for the theory of atomic and molecular absorption and that of Raman scattering. This is easily shown using the equations of the standard model itself, notably the use of a hypothetically massless photon [13,14]. It is shown that the simplistic ideas of Einstein appear to hold only because the conservation of linear momentum was ignored. The usual theory of absorption based on transfer of angular momentum is shown to be a rough approximation to the rigorous theory, which must be based on the conservation of linear momentum transferred from a photon to an electron in orbital 1 of an atom or molecule. Similarly, the simplistic theory of Raman scattering becomes wildly self-inconsistent once linear momentum is considered.

In Section 2 it is shown that the correct consideration of energy and linear

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momentum conservation in the theory of absorption leads to a complicated set of equations and to the definition of a scattering angle in terms of energy changes and energy levels. When applied to atomic H the theory becomes wildly incorrect at a basic level, following the pattern established earlier in UFT 158 to UFT 161 on Compton scattering. The very basics of twentieth century physics fall apart. In order to begin to understand why this should be so, general relativity as corrected by ECE theory can be applied as in UFT 161 to allow the mass of the electron to become correctly covariant. This procedure (the October Postulates of UFT 161) should be considered as a first measure only. There is currently a deep crisis in natural philosophy. It is shown that the usual theory of absorption [13, 14] is a rough approximation to the rigorous law of conservation of linear momentum.

In Section 3 it is shown that the simplistic standard theory of Raman scattering becomes wildly incorrect if conservation of linear momentum is correctly considered. This follows the pattern for scattering theory and absorption theory.

2. Conservation of energy and linear momentum in absorption theory

Consider a photon of energy $\hbar\omega$ interacting with an electron in orbital 1 of an atom or molecule. Conservation of relativistic energy means that:

$$\gamma' m c^2 + \hbar\omega = \gamma'' m c^2 \quad (1)$$

where m is the mass of the electron and where the two Lorentz factors are:

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

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

Here v' and v'' are the linear orbital velocities of the electron in orbitals 1 and 2 of the atom or molecule. Conservation of linear momentum means that:

$$\mathbf{p}' + \hbar\mathbf{\kappa} = \mathbf{p}'' \quad (4)$$

where $\hbar\mathbf{\kappa}$ is the linear momentum of the photon, and where \mathbf{p}' and \mathbf{p}'' are the relativistic momenta in orbitals 1 and 2 respectively:

$$\mathbf{p}' = \gamma m \mathbf{v}', \quad \mathbf{p}'' = \gamma m \mathbf{v}'' . \quad (5)$$

According to Einstein's special relativity, linear momentum is always relativistic,

and is defined by:

$$\mathbf{p} = \gamma m \mathbf{v}. \quad (6)$$

It is well known [15] that the relativistic momentum may be re-expressed as the Einstein energy equation:

$$E^2 = c^2 p^2 + E_0^2 \quad (7)$$

where E is the total relativistic energy:

$$E = \gamma m c^2 \quad (8)$$

and where E_0 is the rest energy:

$$E_0 = m c^2 \quad (9)$$

In Eq. (7) \mathbf{p} is the relativistic momentum. Therefore the energies of the electron in orbitals 1 and 2 are:

$$E_1 = \gamma' m c^2 \quad (10)$$

$$E_2 = \gamma'' m c^2. \quad (11)$$

The basis of twentieth century physics is encapsulated in the de Broglie postulates [16, 17] which merge special relativity and the old quantum theory:

$$E_1 = \hbar \omega' = \gamma' m c^2 \quad (12)$$

$$E_2 = \hbar \omega'' = \gamma'' m c^2. \quad (13)$$

These postulates mean that Eq. (1) is:

$$\omega + \omega' = \omega'' \quad (14)$$

and it may be shown that this result is the same if the photon has mass (see note 162(1) accompanying this paper on www.aias.us). So the usual energy conservation theory of absorption tells us nothing about photon mass and produces just Eq. (14). It is not possible to consider energy conservation without momentum conservation as has been known since Newton's laws. Eq. (4) is:

$$\hbar^2 \kappa^2 = p''^2 + p'^2 - 2p'p'' \cos \theta \quad (15)$$

and if the photon is considered to be massless as in the standard model then:

$$\kappa = \frac{\omega}{c}. \quad (16)$$

Equations (2) and (3) mean that:

$$v'^2 = c^2 \left(\frac{\omega'^2 - x^2}{\omega'^2} \right), \quad v''^2 = c^2 \left(\frac{\omega''^2 - x^2}{\omega''^2} \right), \quad (17)$$

where

$$x = \frac{m c^2}{\hbar}. \quad (17a)$$

So Eq. (15) is:

$$\omega^2 = \omega''^2 + \omega'^2 - 2x^2 - 2(\omega''^2 - x^2)^{1/2} (\omega'^2 - x^2)^{1/2} \cos \theta \quad (18)$$

which is:

$$(\omega''^2 - x^2)(\omega'^2 - x^2) \cos^2 \theta = (A - x^2)^2 \quad (19)$$

where

$$A = \frac{1}{2}(\omega'^2 + \omega''^2 - \omega^2). \quad (20)$$

Solving for x^2 gives:

$$x_1^2 = \frac{1}{2a} \left(-b \pm (b^2 - 4ac')^{1/2} \right) \quad (21)$$

$$a = 1 - \cos^2 \theta, \quad (22)$$

$$b = (\omega'^2 + \omega''^2) \cos^2 \theta - 2A, \quad (23)$$

$$c' = A^2 - \omega''^2 \omega'^2 \cos^2 \theta, \quad (24)$$

$$A = \frac{1}{2}(\omega'^2 + \omega''^2 - \omega^2). \quad (25)$$

Note carefully that this is the result of the standard equations of physics themselves. So the electron mass is a complicated combination of factors and very unlikely to be a constant.

Now eliminate the momenta in favour of the energies by using:

$$E_1^2 = c^2 p'^2 + m^2 c^4. \tag{26}$$

$$E_2^2 = c^2 p''^2 + m^2 c^4. \tag{27}$$

and Eq. (15) becomes:

$$\hbar^2 \omega^2 = E_1^2 + E_2^2 - 2E_0^2 - 2(E_1^2 - E_0^2)^{1/2} (E_2^2 - E_0^2)^{1/2} \cos \theta. \tag{28}$$

Together with Eq. (14) we arrive at the definition of the scattering angle in atomic or molecular absorption:

$$\cos \theta = \frac{E_1 E_2 - E_0^2}{(E_1^2 - E_0^2)^{1/2} (E_2^2 - E_0^2)^{1/2}}. \tag{29}$$

Solving Eq. (28) for E_0^2 it is found that:

$$E_0^2 = \frac{1}{2a} \left(-b \pm (b^2 - 4ac')^{1/2} \right) \tag{30}$$

$$a = 1 - \cos^2 \theta,$$

$$b = (E_1^2 + E_2^2) \cos^2 \theta - 2E_1 E_2,$$

$$c' = E_1^2 E_2^2 (1 - \cos^2 \theta),$$

an equation that must be self consistent with Eq. (9) if standard absorption theory is correct.

For atomic hydrogen H [13]:

$$E_1 = -2.2 \times 10^{-18} \text{ J}, \quad E_2 = -0.55 \times 10^{-18} \text{ J} \tag{31}$$

and if the rest mass of the electron is taken to be the constant of the standards laboratories:

$$m = 9.10953 \times 10^{-31} \text{ kg} \tag{32}$$

then

$$E_0 = 8.1872 \times 10^{-14} \text{ J}. \tag{33}$$

This means that Eq. (29) gives:

$$\cos \theta \sim -1 \tag{34}$$

and Eqs. (30) to (34) give:

$$a = 2, \quad b = (E_1 - E_2)^2, \quad c' = 2E_1^2 E_2^2. \quad (35)$$

It is found that

$$E_0^2 = \frac{1}{4} \left(-(E_1 - E_2)^2 \pm \left((E_1 - E_2)^4 - 8E_1^2 E_2^2 \right)^{1/2} \right) \quad (36)$$

a hopelessly incorrect result giving an imaginary root added to a negative value for mass.

Consider now the angular momentum on the classical level:

$$\mathbf{L} = \mathbf{r} \times \mathbf{p} \quad (37)$$

where \mathbf{r} is the radius vector. By vector analysis:

$$\mathbf{r} \times \mathbf{L} = (\mathbf{r} \cdot \mathbf{p})\mathbf{r} - (\mathbf{r} \cdot \mathbf{r})\mathbf{p}. \quad (38)$$

Consider as an approximation a planar orbit in which \mathbf{L} is perpendicular along the \mathbf{Z} axis to both \mathbf{r} and \mathbf{p} . Then:

$$\mathbf{r} \cdot \mathbf{p} = 0 \quad (39)$$

so:

$$\mathbf{p} = \frac{1}{r^2} \mathbf{L} \times \mathbf{r}. \quad (40)$$

Its magnitude is:

$$p = \frac{L}{r} \sin \alpha \quad (41)$$

where α is the angle between \mathbf{L} and \mathbf{r} . In a planar orbit this is ninety degrees, so

$$p = \frac{L}{r} \quad (42)$$

and

$$L = p r. \quad (43)$$

Therefore, Eq. (15) becomes:

$$L^2 = L'^2 + L''^2 - 2L'L'' \cos\theta. \quad (44)$$

The orbital angular momentum of the photon is:

$$L = \hbar \kappa r. \quad (45)$$

If it is assumed that:

$$\kappa r = 1 \quad (46)$$

then

$$L = \hbar \quad (47)$$

which is the spin angular momentum of the photon. In the usual theory of absorption [13] this is the minimum amount of angular momentum transferred to the atom when a photon is absorbed. It is seen that the usual theory in vector format is:

$$\underline{\hbar} = \underline{L}'' - \underline{L}' \quad (48)$$

and its Z component is:

$$\hbar = L'' - L'. \quad (49)$$

This simplistic theory is just a rough approximation of the law of conservation of momentum (15) and the simplistic theory becomes completely untenable when conservation of linear momentum is properly considered. In the usual theory the photon is said to be massless with two components:

$$L = m_s \hbar, \quad (50)$$

where

$$m_s = \pm 1. \quad (51)$$

Left circularly polarized light is labelled 1 and right circularly polarized light -1. The angular momentum of the electron changes by \hbar when it absorbs left

circularly polarized light. This gives the usual electric dipole selection rule [13]:

$$\Delta l = \pm 1. \quad (52)$$

This theory seems to work, but only if linear momentum conservation is ignored. As pointed out by Einstein many times, his own theory is incomplete and heuristic. We see now that it is totally incorrect. It may be possible to save the hypothesis of Einstein by use of the October postulates of paper UFT 161, if so, the electron mass is expressed as curvature in general relativity. Developing this idea requires the use of finite photon mass for self consistency. In this case, conservation of energy in absorption theory is described by:

$$E_i + \hbar \omega = E_f, \quad (53)$$

where:

$$E_i = \gamma' m_2 c^2, \quad (54)$$

$$E_f = \gamma'' m_2 c^2, \quad (55)$$

$$\hbar \omega = \gamma m_1 c^2. \quad (56)$$

Here m_1 is the photon mass and m_2 the electron mass. It follows that:

$$\omega = \omega'' - \omega' \quad (57)$$

which is the same equation as (14) obtained with zero photon mass. Therefore the use of conservation of energy alone does not give much information. When the photon mass is finite, the law of conservation of momentum becomes:

$$\mathbf{p} = \mathbf{p}'' - \mathbf{p}' \quad (58)$$

where

$$\mathbf{p} = \hbar \boldsymbol{\kappa} = \gamma m_1 \mathbf{v}, \quad (59)$$

$$\mathbf{p}'' = \hbar \boldsymbol{\kappa}'' = \gamma'' m_2 \mathbf{v}, \quad (60)$$

$$\mathbf{p}' = \hbar \boldsymbol{\kappa}' = \gamma' m_2 \mathbf{v}', \quad (61)$$

Therefore,

$$\kappa^2 = \kappa''^2 + \kappa'^2 - 2\kappa'\kappa'' \cos\theta \quad (62)$$

where

$$\kappa = \omega v / c^2, \text{ etc.} \quad (63)$$

So Eq. (62) is:

$$\omega^2 v^2 = \omega'^2 v'^2 + \omega''^2 v''^2 - 2\omega'\omega''v'v'' \cos\theta. \quad (64)$$

If:

$$x_1 = \frac{m_1 c^2}{\hbar}, \quad x_2 = \frac{m_2 c^2}{\hbar}. \quad (65)$$

The velocities may be eliminated from Eq. (64) to give:

$$\omega^2 - x_1^2 = \omega'^2 - x_2^2 + \omega'^2 - x_2^2 - 2(\omega'^2 - x_2^2)^{1/2}(\omega'^2 - x_2^2)^{1/2} \quad (66)$$

in which the photon mass and electron mass are not constants. The photon mass is given by:

$$x_1^2 = \frac{1}{2a} \left(-b \pm (b^2 - 4ac')^{1/2} \right) \quad (67)$$

$$a = 1 - \cos^2 \theta, \quad b = (\omega'^2 + \omega'^2) \cos^2 \theta - 2A, \quad (68)$$

$$c' = A^2 - \omega'^2 \omega'^2 \cos^2 \theta. \quad (69)$$

As in UFT 161, the photon and electron masses must be reinterpreted as covariant masses of ECE theory in order to begin to forge a new physics.

3. Theory of Raman scattering with conservation of linear momentum

In Stokes Raman scattering [13] a photon is scattered from an electron in orbital 1, and the photon's original angular frequency ω go is changed to a lower angular frequency ω' . The electron increases energy from E_i to E_f . Therefore conservation of energy means that:

$$\hbar\omega + E_i = \hbar\omega' + E_f. \quad (70)$$

The de Broglie postulate applied to the electron means that

$$E_i = \hbar\omega_i, \quad E_f = \hbar\omega_f \quad (71)$$

and therefore:

$$\omega + \omega_i = \omega' + \omega_f. \quad (72)$$

Conservation of momentum means that:

$$\hbar \boldsymbol{\kappa} + \mathbf{p}_i = \hbar \boldsymbol{\kappa}' + \mathbf{p}_f. \quad (73)$$

Therefore:

$$E_f - E_i = \hbar(\omega - \omega_i), \quad (74)$$

$$\mathbf{p}_f - \mathbf{p}_i = \hbar(\boldsymbol{\kappa} - \boldsymbol{\kappa}'). \quad (75)$$

The electron energies and momenta are related by:

$$E_i^2 = c^2 p_i^2 + m^2 c^4, \quad (76)$$

$$E_f^2 = c^2 p_f^2 + m^2 c^4. \quad (77)$$

It is enough to consider a massless photon to show the severe problems that arise when Raman scattering is correctly developed. For a massless photon:

$$\omega = \kappa c, \quad \omega' = \kappa' c'. \quad (78)$$

From Eqs. (76) and (77):

$$E_i^2 + E_f^2 = c^2 (p_i'^2 + p_f'^2) + 2m^2 c^4 \quad (79)$$

and from Eqs. (74) and (75):

$$\hbar^2 (\omega^2 + \omega'^2 - 2\omega\omega') = E_f^2 + E_i^2 - E_i E_f \quad (80)$$

$$\hbar^2 (\kappa^2 + \kappa'^2 - 2\kappa\kappa'\cos\theta) = p_f^2 + p_i^2 - 2p_i p_f \cos\theta. \quad (81)$$

Using Eq. (78) in Eq. (81):

$$\hbar^2 (\omega^2 + \omega'^2 - 2\omega\omega'\cos\theta) = E_f^2 + E_i^2 - 2m^2 c^4 - 2p_i p_f \cos\theta. \quad (82)$$

Subtracting Eq. (82) from Eq. (80):

$$E_i E_f - c^2 p_i p_f \cos\theta - m^2 c^4 = \hbar^2 \omega \omega' (1 - \cos\theta). \quad (83)$$

The momenta may now be eliminated in favour of the known energies to give:

$$(E_i^2 - E_0^2)^{1/2} (E_f^2 - E_0^2)^{1/2} \cos\theta = A - E_0^2, \quad (84)$$

$$A = E_i E_f - \hbar^2 \omega \omega' (1 - \cos\theta). \quad (85)$$

Finally, this equation is solved for E_0^2 to give:

$$E_0^2 = \frac{1}{2a} \left(-b \pm (b^2 - 4ac')^{1/2} \right) \quad (86)$$

where

$$a = 1 - \cos^2 \theta, \quad (87)$$

$$b = (E_i^2 + E_f^2) \cos^2 \theta - 2A, \quad (88)$$

$$c' = A^2 - E_i^2 E_f^2 \cos^2 \theta. \quad (89)$$

Here E_i and E_f are the initial and final electron energies in the Raman spectrum and θ is the scattering angle of the Raman spectrometer. So this equation is a severe test because E_0^2 must be constant. It is very unlikely that this will be the case, judging by previous drastic failures in the theory of Compton scattering and absorption.

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