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EMISSION AND ABSORPTION OF PHOTONS DUE TO THE RELATIVISTIC EFFECT

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Abstract: In the present work, we have discussed the relaxation time at higher frequency due to the relativistic treatment, does not effect the emission or absorption of photon like the non-relativistic treatment in the case of the emission or absorption of phonons.
Keywords – Phonons, Photon and Crystal lattice

1. INTRODUCTION

Kirichok et al. had shown that the intensity of absorption and emission lines at the natural frequency (w0) of the oscillator significantly exceeds the intensity of other spectral lines, particularly at frequencies (w0+w), which is caused by the equality of the oscillation energy in the potential well to the recoil energy [1]. Cianchi et al. had shown that the relaxation rate for the mixed process turns out to be proportional to the relaxation rate for the resonant second order Raman process, the constant of proportionality being three orders of the magnitudes smaller than unity[2]. The relaxation time for the non-ionic surface is much longer than for ionic surface, because of the absence of ionic repulsion between the head groups[3]. Tzung Han Chou and Chien-Hsiang Chang investigated the thermodynamic behaviour and relaxation process of mixed DPPC/cholesterol mono-layers at the air/water interface at 370C and obtained the surface pressure area and the relaxation curves[4]. Malaecu et al. studied the magnetic relaxation processes in two ferro fluids with two samples MnO.4ZnO.6Fe2O4 and MnO.6FeO.4Fe2O4 of the mixed ferrite particles and observed for both samples at frequencies of tens MHz, assigned with relaxation processes with evaluation of the effective anisotropy constant K of the particles [5]. Habasaki et al.studied the molecular dynamics simulation (MD) of lithium metasilicate and related mixed alkali system and observed the changes in the mean squared displacement and the corresponding clear two-step relaxations in a density correlation function at 700 K for each ion [6]. Reich also studied the different type of relaxation process and relaxation time specially with NMR spectroscopy[7]. Taylor and Austin used a radioactive source containing cobalt diffused into a palladium foil and studied the Co57 nuclei decay by electron capture to Fe 57, leaving the Fe57 in an excited nuclear state, which results to give that the energy state of 14.4 keV state decays by photon emission 11% of the time, and the remaining decays occur by atomic electron ejection and the transition with the highest Mossbauer probability is from the 14.4 keV excited state to the ground state[8]. Abdel-Ghany et al. studied the hyperfine structure of iron using the Mossbauer effect spectroscopy and measured the density and molar volume experimentally [9]. Gabbasov et al. investigated the size dependence of Mossbauer parameters for iron oxide nanoparticles in the 10–25 nm range and shown that the isomer shift and hyperfine field parameters decrease with the nano-particle size and also only at 25 nm the presence of magnetite was detected[10]..

In the present work, we have discussed the relaxation time at higher frequency due to the relativistic treatment, does not effect the emission or absorption of photon like the non-relativistic treatment in the case of the emission or absorption of phonons.

2. THORETICAL DISCUSSION

The scattering of high energy photons by free electrons results the decrease in the energy of photons due to the recoil effect in the case of Compton effect and photoelectric effect and these two effects lead to the confirmations of the basic principle of quantum theory of radiation. In the case of low frequency quantum oscillation, the relaxation of low frequency motion in the potential well plays significant role and the relaxation does not effect the emission and absorption of high frequency photon[1].

Let us suppose that the particle occupies the lowest energy level in an external potential well and consider the case when it remains inside the well after the quantum emission or absorption.

When the energy at a high frequency quantum is absorbed, the particle oscillator gets recoil momentum mV and hence the quantum energy emitted by the particle oscillator with natural frequency w0 is the same to due to the recoil effect.

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Now applying the principle of conservation of energy and momentum in the case of quantum absorption, the probability of emission of a low-frequency phonon is given by the following equation[1].

$$\frac{\hbar\omega_0}{2mc} \quad \text{.....} \quad (1)$$

The relatively low velocity acquired by an oscillator due to the recoil is often significantly less than the phase velocity of the phonons

$$v_s \frac{\hbar\omega_0}{2mc} \quad \text{.....} \quad (2)$$

This makes impossible direct transfer of kinetic energy to photon.
The relaxation time of the low frequency oscillation is given by the following equation.

$$\tau_{LF} \frac{8\pi\hbar\omega_0}{m\omega_s^2} \quad \text{.....} \quad (3)$$

But, when τ_{LF} far exceeds the life time of high frequency quantum the relaxation process does not affect the behaviour of emission and absorption as proposed according to the above consideration.

In the case of three dimensional case, the characteristic relaxation time of low frequency motion is given by the following equation[1].

$$\tau_{LF} \frac{3\hbar\omega_0}{2\omega_s^2\omega_0^2} \quad \text{.....} \quad (4)$$

$$m \quad \text{(illegible)}$$

In the present work, we apply the same relaxation process for the emission or absorption of photons at high frequency using the variation of mass with velocity, since the velocity will increase with increase of the frequency of radiation by the following relation.

$$E = h\nu \quad \text{.....} \quad (5)$$

As per the above relation, the increase in the frequency of radiation increases the energy of the photon. The increase in energy will increase the kinetic energy so that the velocity will be increased after the absorption of large amount of energy.

From the variation of mass with velocity as proposed by Albert Einstein[11,12], we have

$$m \quad \frac{m_0}{\text{...}} \quad \text{...} \quad (6)$$

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$$1 - \frac{v^2}{c^2}$$

$$m = m_0 \left(1 - \frac{v^2}{2c^2}\right) \quad (7)$$

using the binomial theorem to expand the above expression, we have

$$m = m_0 \left(1 - \frac{1}{2}\frac{v^2}{c^2}\right) \quad (8)$$

The emission of photons is possible only when the velocity of photon is comparable to the velocity of light and hence, in this case, we have

$$v \approx c \quad (9)$$

With the help of equation(8), we have

$$m = m_0 \left(1 - \frac{1}{2}\right) \quad (10)$$

$$m = m_0 \left(1 - \frac{1}{2}\frac{v^2}{c^2}\right) \quad (11)$$

$$m = \frac{m_0}{\frac{3}{2}} \quad (12)$$

From the equation(3), we have

$$E = m_0 c^2 \quad (13)$$

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With the help of equation (12), the above equation becomes

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or □ HF □ □ □ (15)
□ □ m0
3 □ □

where

□ l = The wavelength oflight in the form of photon.
m0= The rest mass of the photons.

3. RESULT AND DISCUSSION

The work is started with the application of the principle of conservation of energy and momentum in the case of quantum absorption or emission of a low-frequency phonon from the crystal and their frequency is given by the equation(1). The relaxation time of the low frequency oscillation is given by the equation (3). The same matter in the case of three dimension can be represented by the equation(4) and had shown that the relaxation process does not affect the character of emission and absorption of phonons at high frequency.

In the present research work, we have discussed the relaxation time at higher frequency due to the relativistic treatment, does not effect the emission or absorption of photon like the non-relativistic treatment in the case of the emission or absorption of phonons.

In the present case, we have used the quantum energy and the variation of mass with velocity to give a model for the relaxation time at higher frequency represented by the equation(15).

Since, we know that the rest mass of the photon is zero, so as per equation(15), the relaxation time at higher frequency becomes infinity due to the relativistic effect, but the physical significance of infinite relaxation time becomes meaningless so that the absorption or emission of photon is not possible.

4. CONCLUSION

The relaxation time does not effect the emission or absoption of photon due to the relativistic treatment at higher frequency, like the non-relativistic treatment in the case phonon absorption or emission at higher frequency.

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