

Nature and Properties of Light and Radiation: Corpuscular Sphere Theory

Padiga Chandrasekhar Reddy

002, Gangotri Palm Groove, Revenue Lay-Out, 22nd Main Road, Padmanabha Nagar,
Bangalore, Karnataka, India – 560 070

Abstract: A new theory has been developed for the nature and properties of radiation which is the modified corpuscular theory and named as corpuscular sphere theory of light and radiation. All the properties of light and radiation like the phenomenon of diffraction and interference inverse square law, photoelectric effect and relativistic mass are clearly explained by the present theory with number of new deductions.

I. Introduction:

The study of the nature and properties of the light began with Newton. He indeed had defended the hypothesis of corpuscular nature of light but the assumptions which he cited to support his views were found to be incapable in explaining some of the properties of light like the phenomenon of diffraction interference etc. this initiated Hygene to introduce the wave theory of light. These two classical conceptions are contradictory to each other and neither can explain all properties of light independently.

The development of the modern conception of light quanta or photons began with Planck's¹ ideas concerning heat radiation emitted from a block body. In order to accomplish his experimental results on the block body radiation he introduced a simple assumption that the oscillators in the hot body can emit radiation only in units or quanta whose energy is proportional to the frequency of radiation and these units are not corpuscular. He assumed that the radiation from on oscillator, though having a definite amount of energy would spread itself through a space after the manner of a spherical electromagnetic wave. It remained for Einstein² introduce the concept related to particle nature of light and named it as photon and with the help of photon concept he successfully explain the photoelectric effect. The experimental results of inverse photoelectric^{3,4} and Bhor's picture of emission and absorption of energy by the atoms⁵ involving the complete transfer of energy. It is considered impossible that an electromagnetic wave whose energy spreads in all directions should effect such a sudden and complete transfer of radiation energy is obvious. It is clear that Einstein's photon concept afford a simple and adequate explanation for such complete transfer of radiant energy. There have not been lacking, however attempts to explain these phenomena with out resorting to assumptions departing so completely from the electro magnetic waves of Maxwell. One such attempt is the accumulation hypothesis according to which the light energy is gradually accumulated by the atom and the photo electron is finally affected when the accumulated energy exceeds a certain critical valve. The experimental results of wilson⁶ Bubb⁷ and others⁸⁻¹¹ reveal that the accumulation hypothesis does not seem to be tenable. If the atom can't gradually accumulate energy, since a spherical electromagnetic can't give up its whole energy to a single atom, the occurrence of photoelectrons with the energy $h\nu$ ⁸, means that we must abandon either the spherical wave nature of light or the doctrine of the conservation of energy. Bohr, Kramer and Slater¹² at one time preferred to assume that energy is not conserved when an individual photo electron is produced by treating the conservation of energy and momentum are statistical laws. The experiments performed by C.T.R Wilson, W.Bothe¹³ A.H ximptin¹⁴ and A.A Bless¹⁵ on the scattering of X-Rays concluded that the photon theory in detail predicts quantitatively the change of wave length of scattered X-rays and the characteristics of recoil electrons. The virtual radiation theory is probably not inconsistent with the experiments but is in capable of predicting the results. The results of the experiments performed on photoelectric effect and scattering of X-rays can't be reconciled with the classical picture of electromagnetic waves, they don't suffice to distinguish between the photon theory and the theory of virtual radiation. The virtual radiation theory succeeded in avoiding the difficulties of classical theory by considering the conserving of energy and momentum as only statistically valid. Bothe¹⁶ and geiger¹⁷ and Compton and Sinon¹⁸ performed the experiments on the interaction of individual photons and electrons to make direct test for the conservation principles and to distinguish between the virtual radiation hypothesis and that of photons. The results of these experiments are incomplete accordance with the predictions of the photon theory and are disagreed with the virtual radiation hypothesis.

Thus the experiments on the photo electric effect and on scattered X-Rays are taken together with these experiments on individual interactions of radiation and electrons, shows therefore that the radiation is emitted in units, is propagated in definite directions and is absorbed again in units of undiminished energy provides an ample of evidence that light has all essential characters of particles. The phenomenon of diffraction and

interference, polarization etc.; which occur with the light that can leave no reasonable doubt about its wave properties. It has remained as a big puzzle for reconciliation of two apparently conflicting conceptions. The point of departure of this conflict is L. De Broglie's mathematical proof¹⁹ that the dynamics of any particle may be expressed in terms of the propagation of a group of waves and the momentum of a particle is inversely proportional to the wave length.

Perhaps enough has been discussed to show that by grasping both horns we have found to possible to overcome the dilemma. Though no simple picture has been invented affording a mechanical model of a light ray by combining the conceptions of waves and particles a logically consistent theory has been devised which seems essentially capable of accounting for the properties of light thus the conflict of the centuries was concluded that the light propagated as electromagnetic waves yet the energy of the light is concentrated in particles associated with the waves and when ever the light does something It dies it as particles.

Explanation of the properties of light and radiation is not sufficed to certify the validity of the proposed nature of light. It is capable in explaining the numerous problems in the mechanics of micro particles. Since the change of the energy of the micro particles is mainly associated with the absorption or emission of radiation indeed one of foundation concept of quantum mechanics the De Broglie's mathematical proof was deduced by correlating the Planck's quantum theory and Einstein theory of relativity. The most important contribution of the theory of relativity to the mechanics of micro particles is the relativistic mass. That is the variation of particle mass with its velocity and creation of abstract particles(zero mass particles), but it was not provided the proper physical interpretation to establish the relation between velocity of micro particles and that of light and also to answer why not the material particles achieve the velocity of light?. Another interesting phenomenon is that the mass defect. It is well known fact that the amount of energy emitted in nuclear reactions in the form of photons was calculated based on the mass defect treating that the mass was converted into energy that is photons but again assigning the zero mass for photons is not appropriate and sustainable. On the other hand Otto stulman who performed a lot of experiments to verity the Einstein theory of photo electric effect, described in his paper²⁰ that the photo electric emission is not caused by the absorption of light energy, but the light acts only as an agent in setting the electrons free from their parent atoms and the W. Cornelius²¹ calculated the minimum required velocity of the photo electrons to escape from nuclear field of attraction is around 10^7 cm/s for alkali metals and described the work function as the energy required to drag the electrons to the surface of the metal. But Einstein equation permits the ejection of very low velocity electrons at just above the threshold frequency and is negligible compared to the velocity of atomic electrons which is not practically possible. The above cited experimental evidences and logical conception require a still more appropriate understanding of the nature of light and radiation. Keeping all these in view an attempt has been made to study some of the important properties of light and radiation by assigning he corpuscular sphere nature of light and radiation.

Modern Corpuscular Theory Of Light And Electromagnetic Radiation:

The basic idea of the proposed hypothesis of corpuscular sphere nature of light and radiation was indeed generated from Newton's corpuscular theory of light but the validity of the assumptions he cited was critically evaluated and modified in order to explain the experimental results. Hence the complete description of the assigned properties of corpuscles is essentially needed to move forward in the present investigation.

- 1) Light and all forms of electromagnetic radiation consist of very tiny particles known as "corpuscles" but unlike Newton, the corpuscle is a particle having definite mass, size, velocity, momentum and energy. All corpuscles are identical in all respects.
- 2) These corpuscles are smallest and tiny particles in the universe having independent existence. It is the nature's gift that the independent corpuscles are always traveling with a velocity 'C' that is equal to the 2.9979524×10^8 m/s in vacuum. This special property of the corpuscles is the responsible of all forms of energy in the universe. Thus the energy of the corpuscles is only the source of all forms of energy in the nature.
- 3) The corpuscles could neither be created nor destroyed by any physical and chemical process; hence the number of corpuscles present in universe remains unchanged. Since each corpuscle has a definite amount of energy the total energy of the universe remains constant this is the reason for the sustainability of all conservation laws.
- 4) The universal constant (h) introduced by Planck to relate the energy with the frequency (ν) is not a derived quantity but it is an experimentally determined quantity. The quantity of energy 'h' determined by Planck is the energy of a corpuscle, hence the mass of the each corpuscle should be $7.372615098 \times 10^{-51}$ Kg. There fore corpuscles are the lightest and tiniest particles in the universe.
- 5) Like other particles the corpuscles can produce a mechanical motion in the objects but it is very low.
- 6) During the absorption of radiation or light by the matter, the corpuscles are absorbed by the constituent particles of matter and the energy of the corpuscles is shared by both. Thus the energies as well as velocities of the corpuscles and constituent particles are altered in accordance with Newton's laws.

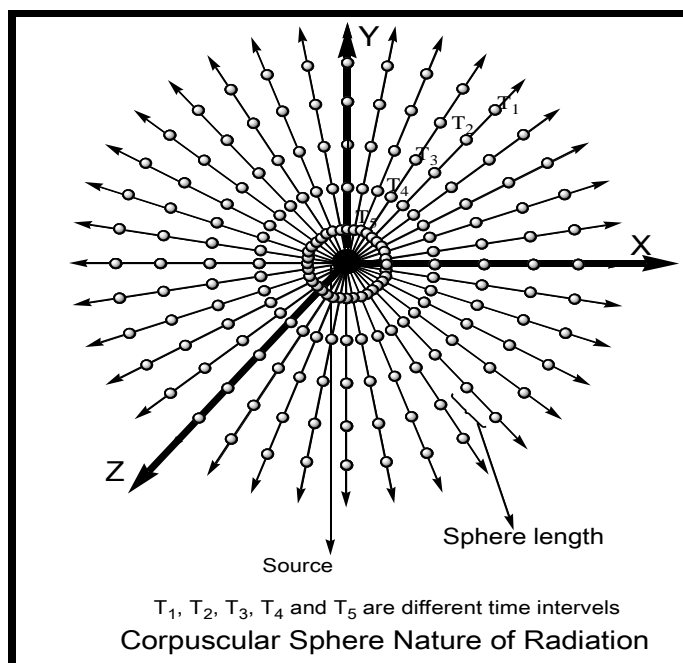
- 7) Once the corpuscles are ejected from the source with a velocity 'C' it is completely independent and remains unaffected by the motion of source.
- 8) These corpuscles on emission from the source travel in straight line with high velocity 2.9979524×10^8 m/s in vacuum in systematic way making definite angle with three co-ordinate axis that is responsible for the phenomenon of diffraction and interference.
- 9) The properties of the radiation and its interaction with matter is completely depends on the frequency of the emission and propagation of corpuscular spheres from the source.
- 10) All the micro particles in the universe are composed with a cluster of corpuscles thus the universe is composed with corpuscles and corpuscles are the ultimate particles of the entire matter in the universe. It is evidenced by positron annihilation. During positron annihilation both positron and electron are disappeared and only corpuscles are ejected with high frequency. Different number of corpuscles are combined together resulting number of micro particles. Owing to different number of corpuscles forming different clusters different micro particles are producing some are stable and most of them are unstable. The unstable micro particles always trying to convert into stable particles by emitting substantial number of corpuscles in the form of radiation.
- 11) As long as corpuscles are traveling with a velocity 'C' they are neutral and possess no charge and magnetic behavior but when they absorbed by any matter or micro particle part of its energy is converted into its spin energy. Owing to its spin they developed substantial charge on them. Since two types of spin is possible that is clock wise and anti clock wise spin due to which two types of charge namely positive and negative charges as well as magnetic properties are developing.

Corpuscular sphere nature of radiation

The principle of the conservation of energy clearly described that the emission of radiation always takes place at the expense of other forms of energy and hence it follows that only material particle (Not Geometrical volumes or surfaces) either emit or absorb the radiation. It can be transparently observed in Bohr's picture of atom and confirmed through the hydrogen spectrum where in, the energy in the form of radiation is emitted during the particle transition from higher energy state E_n to the lower energy state (E_1). The difference of the energy of these two states $\Delta E = (E_n - E_1)$ emits in the form of radiation. Therefore it is clear and beyond any conflict that the particle transitions are only the source of all forms of energy and the mechanics of the micro particles is inevitably depend on the amount of energy associated with them. It is theoretically predicted and experimentally determined fact that the mass of the micro particles is varying in accordance with velocity and hence the energy. It implies that the energy is always in the form of mass and strongly supported by Einstein's mass energy equivalence principle. Therefore both mass and velocity are variables in accordance with energy of the micro particles.

Consider that the amount of energy liberated is in the form of corpuscles and (as described in the properties) they are only the source of all forms of energy, then it is clear that all material particles are always associated with substantial number of corpuscles and the energy of the material particles is totally contributed by the associated corpuscles. When the material particle deexcited from higher energy level to a lower level a substantial number of corpuscles are dissociated by regaining their contributed energy and acquired the velocity 'C' suppose the initial and final energies of a particle are E_i and E_f respectively and the difference of the energy of these two states is mC^2 which is ejected in the form of radiation as corpuscles during particle transition. Since 'C' is the maximum velocity assigned to a corpuscle the energy is equal to its total energy $E = mC^2$. All the ejected corpuscles in an event travels in straight line with velocity 'C' in the three dimensional space after any time (t) they are all at equidistance 'Ct' from the source. These fetch the shape of the surface of a sphere for corpuscles with radius 'Ct'. This is appeared as corpuscular sphere nature of radiation. Suppose the successive particle transitions are taking place in source with time interval ' Δt ' then the successive corpuscular spheres should be generated with difference of radii 'Ct'. Since all the corpuscles have the same velocity 'C' the distance between any two successive corpuscular spheres remain constant, throughout thus the propagation of the corpuscles in the shape of spherical surfaces appears to be a train of waves. But in reality it's all a systematic propagation of corpuscles (fig.1). The number of corpuscular spheres emitted in a unit time or sphere frequency ' \mathcal{G} ' and the distance between any two successive corpuscular spheres length ' λ ' are related with a equation

$$C = \lambda \nu$$



Thus though the radiation is of purely corpuscular nature the systematic emission and propagation create an illusion of wave nature hence it requires no media for propagation. Each corpuscle always travels in straight line making definite angle with coordinate axis. This property of the propagation of corpuscles results the phenomenon of diffraction and interference. The intensity of the radiation depends on the number of corpuscles present in a unit area of the corpuscular sphere which is varying inversely with the square of the distance from the source.

Sphere number

It is defined as the number of corpuscular spheres present in a unit length and denoted by ' $\bar{\nu}$ '. The terms sphere frequency; sphere distance and sphere number are finding almost same significance of wave frequency wave length and wave number respectively. Hence, the same symbols are adopted in the present hypothesis to avoid the confusion.

Energy of radiation

As defined earlier, the intensity (I) of radiation is the energy associated with the corpuscles present in unit area on the surface of the corpuscular sphere. Hence the amount of energy associated in each corpuscular sphere is 'Ia' (a = area of the corpuscular sphere). Since the number of corpuscular spheres emitted in one second are ' ν ' then the amount of energy emitted in a second $E = Ia\nu$ ----- (1)

The amount of energy emitted in terms of mass $E = mC^2$ ----- (2)

Therefore from equations (1) and (2) $mC^2 = Ia\nu$

$$\therefore mC = Ia/\lambda \qquad \qquad \qquad \therefore C/\nu = \lambda$$

$$p = Ia/\lambda \qquad \qquad \qquad \text{----- (3)}$$

Therefore from equation (3) at constant emission of energy of radiation at any point 'Ia' is constant and considers it as proportionality constant then momentum of the corpuscles is inversely proportional to the sphere length ' λ '. This is clear physical interpretation of the De Broglie's Mathematical equation.

Inverse square law

According to the present theory the intensity of the radiation is basically defined as 'the number of corpuscles present on the unit area of the corpuscular sphere. Since the number of corpuscles emitted in an event is remains unchanged the intensity of the radiation is depends only on the surface area of the corpuscular sphere which has the inversely proportional to the square of the distance between the source and point of observation. From the equation (1) the intensity to the radiation in terms of energy

$$I = E / \mathcal{G}a$$

$$I = E / \mathcal{G} 4\pi r^2 \qquad \because a = 4\pi r^2$$

a = surface area of the corpuscular sphere, $E / 4\pi$ is constant for any particular radiation and the number of corpuscles and number of corpuscular spheres \mathcal{G} are remains constants therefore $E / 4\pi \nu$ is remains constants. Hence the equation

$$I = \left[\frac{E}{4\pi\nu} \right] \frac{1}{r^2}$$

$$I \propto \frac{1}{r^2}$$

There fore the Intensity ‘I’ of the radiation is inversely proportional to the square of the distance between the point of observation and the source.

Then the Intensity, of the radiation at any two given reference points, (X₁) and (X₂) are I₁ and I₂ respectively.

Then the Intensity at the point X₁ is $I_1 = E / 4\pi r_1^2$

The Intensity at the point X₂ is $I_2 = E / 4\pi r_2^2$

$$\therefore \frac{I_1}{I_2} = \frac{r_2^2}{r_1^2}$$

Employing the equation the solar constants of varies planets were calculated based on the earths solar constant. It is known as “*inverse square law*”.

Change of the mass of the micro particles with velocity.

One of the important concepts derived and experimentally verified concept from the theory of relativity was the relativistic mass on which the modern physics especially mechanics of micro particle depends. It is of purely mathematical deduction and provides no appropriate physical interpretation for the change of mass of the particles with velocity with out change in material quantity and also furnish no reasonable information for the impossibility in achieving the velocity of light by the micro particles (material particles) and fail to establish the existing relation between experimentally verified velocity of the light and that of particles.

The present theory provides excellent physical interpretation and satisfactorily furnished the relation exist between velocity of light and that of the mass of the micro particles based on Newtonian mechanics. Consider a particle initially having the rest mass m₀ and by the absorption energy (E = mC²) in the form of corpuscles accelerated to the velocity ‘V_r’ and acquires the mass ‘M_r’. According the law of conservation of energy

$$M_r V_r^2 = m_0 V_0^2 + mC^2$$

$$m_r V_r^2 = mC^2 \quad \text{----- (4)} \qquad \because V_0 = 0$$

$$M_r = m \frac{C^2}{V^2} \quad \text{----- (5)}$$

M_r is equal to the sum of the rest mass (m₀) and mass of the corpuscles m

$$M_r = m_0 + m$$

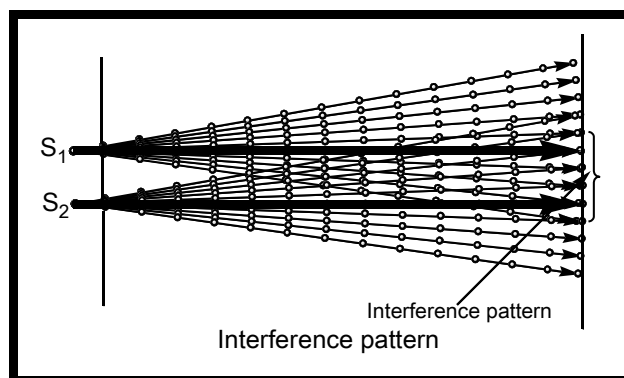
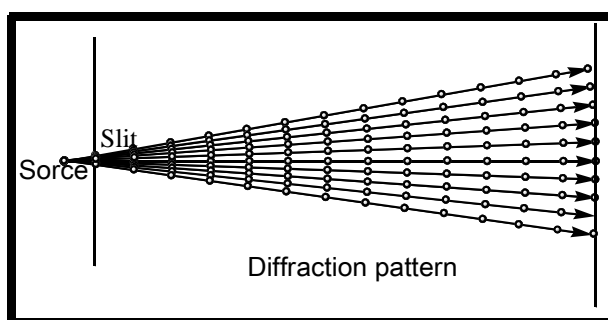
The equation (5) so not permits the C^2/V^2 to reach unity. It implies that since the accelerating particle (corpuscles) having the maximum velocity ‘C’ and they are contributing a fraction of their energy to accelerate the material particle under consideration. Hence it is impossible for any micro particle to achieve the velocity equal to ‘C’. the calculated values furnished in table (1) and the constant values obtained for e/m₀ for very long range of M_r/m₀ values are the evidence for the acceptability of the present theory. Therefore it is clearly concluded that corpuscles are not abstract particles they do possess mass and they are only the driving force for all micro particles, the increase in mass with velocity of the particles is only due to accumulation corpuscles. Substituting the values of mass (m) and velocity (C) in Newtonian mechanics it is possible to extend it to mechanics of the micro particles.

S.No	M/m ₀	V ² = mC ² /M mts	V ² /C ²	Specific Charge $\frac{e}{m_0} = \frac{e}{m} \left[\frac{C^2}{V^2} - 1 \right]$
1	1.00 00 00 001	8.987551778 E07	9.999 999E-10	1.758804786 E11
2	1.00 00 001	8.97550888 E09	9.999 999E-09	1.758804786 E11
3	1.00 001	8.987461913 E11	9.999 900E-06	1.758804786 E11
4	1.001	8.978573214 E13	9.990 009E-04	1.758804786 E11
5	1.1	8.170501625 E15	9.090 909E-02	1.758804786 E11
6	1.2	1.497925298 E16	0.166 666 6	1.758804786 E11
7	1.4	2.567871939 E16	0.285714285	1.758804786 E11
8	1.6	3.37033192 E16	0.3375	1.758804786 E11
9	1.8	3.994467461 E16	0.444 444 444	1.758804786 E11
10	2.0	4.493775893 E16	0.500 000	1.758804786 E11
11	3.0	5.991701191 E16	0.666 666 666	1.758804786 E11
12	5.0	7.19004143 E16	0.8	1.758804786 E11
13	7.0	7.703615817 E16	0.857 142 857	1.758804786 E11
14	9.0	7.988934922 E16	0.888 888 888	1.758804786 E11
15	11.0	8.170501625 E16	0.909 090 909	1.758804786 E11
16	101	8.898566126 E16	0.990 099 099	1.758804786 E11
17	1001	8.978573214 E16	0.999 000 999	1.758804786 E11
18	100 001	8.987461913 E16	0.999 99	1.758804786 E11
19	100 00 001	8.987550888 E16	0.999 999 9	1.758804786 E11
20	100 000 0.001	8.987551778 E16	0.999 999 999	1.758804786 E11

Rest Mass of the Electron (m₀) = 9.109534 E – 31Kg
 Velocity of Light (C) = 2.99792458 E 08m/s
 Charge of the Electron (e) = 1.6021892 E-19 C

Diffraction and Interference

Conclusive evidence of the correctness of a corpuscular sphere model came with the explanation of observed diffraction and interference. When light passes an obstacle, the shadow is not precise and sharp as geometrical ray theory would predict, but rather diffracted a little into the dark region behind the obstacle, thus giving the shadow a fuzzy edge. This property of light that causes it to spread out as it travels by sharp edges or through tiny holes can be explained by light having corpuscular sphere nature. In corpuscular sphere nature each corpuscle is traveling in definite direction making definite angle with three co ordinate axis that property of corpuscles is responsible for the phenomenon of diffraction and interference as illustrated below

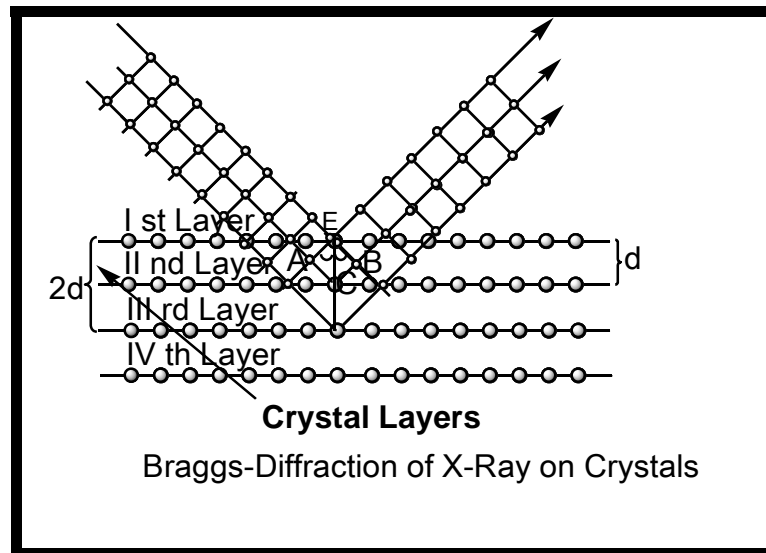


Diffraction in Crystals: Braggs' Equation

Bragg studied diffraction of X – Rays on the crystals using Wave nature of radiation, but in the present theory more reliable explanation was provided with corpuscular sphere nature of radiation as follows.

Consider a narrow beam of light incident on surface of a crystal. Some of the corpuscles present on the surface of the corpuscular sphere reflected from the first layer of the crystal and some are reflected from second layer and so on. The corpuscles reflected from second layer are travel the excess distance ACB compared to the corpuscles reflected from first layer and it is equal to the $2d \sin \theta$ distance.. If this distance is exactly integral multiple of the sphere distance (λ) then only the corpuscles reflected from second layer are joined with subsequent corpuscular spheres of the reflected beam that results diffraction pattern in crystals.

$$n\lambda = 2d \sin \theta$$



Doppler Effect: CS Hypothesis

The phenomenon of the change in the frequency of the radiation due to the motion of the source or observer or both relative to one another is known as Doppler Effect, which finds a wide range of applications in physics and was explained on the basis of wave nature of radiation assuming that the wave length is remains unchanged. The present hypothesis provides an exemplary explanation to this important phenomenon.

Consider the source and observer are at rest relative to one another and the stationary source emits the radiation in the form of corpuscular spheres with time interval 'T' resulting a sphere distance $CT = \lambda$ and sphere frequency $\nu = 1/T$ with respect to the stationary observer. The same is not true when there exists the relative motion between source and observer.

Case: I

Consider that the source is stationary and the observer is moving towards the source with velocity V. Due to the motion of observer towards the stationary source the time interval with which the observer received the corpuscular spheres is changed in accordance the velocity V. Hence the apparent time interval 'T₁' with respect to the observer

$$T_1 = T + \frac{\lambda}{v} = T \left[1 + \frac{C}{v} \right]$$

The apparent sphere frequency ' ν_1 ' is equal to

$$\nu_1 = \nu \left[1 + \frac{v}{C} \right]$$

The apparent sphere distance ' λ_1 ' is equal to

$$\lambda_1 = \lambda \left[\frac{C}{C+v} \right] \text{----- (1)}$$

Case: II

Consider that the source is moving towards the stationary observer with a velocity 'V'. Hence the position of the source is constantly changing towards observers. During the time interval 'T' at which the corpuscular sphere travels a distance 'λ' the source can displace a distance $\frac{\lambda}{v}$ towards observer. Hence the source displaces a distance $\frac{\lambda}{v}$ during the motion of two successive corpuscular spheres result the decrease in the time interval with which the observer receives the corpuscular spheres and sphere distance and increase in sphere frequency. Hence the apparent time interval 'T_{II}' is equal to

$$T_{II} = T \left[1 + \frac{v}{C} \right]$$

The apparent sphere frequency is equal to

$$\nu_{II} = \nu \left[1 + \frac{v}{C} \right]$$

The apparent sphere distance 'λ_{II}' is equal to

$$\lambda_{II} = \lambda \left[\frac{C}{C+v} \right] \text{----- (2)}$$

Therefore the shift in the sphere distance is

$$\Delta\lambda = \lambda \left[\frac{v}{C+v} \right]$$

Equation (1) and (2) are similar hence the Doppler Effect is symmetrical with respect to the radiation.

Case: III in the case at which the source is stationary and observer is moving away from the source with velocity 'V', the position of the observer changing away from the source with respect to the time 'T' by a distance 'VT'. Hence the apparent time interval with the observer receiving corpuscular spheres is

$$T_{III} = T - \frac{\lambda}{v}$$

Hence the apparent sphere frequency 'ν_{III}' is

$$\nu_{III} = \nu \left[1 - \frac{v}{C} \right]$$

The apparent sphere distance 'λ_{III}' is

$$\lambda_{III} = \lambda \left[\frac{C}{C-v} \right] \text{----- (3)}$$

Therefore the shift in the sphere distance is

$$\Delta\lambda = \lambda \left[\frac{v}{C-v} \right]$$

Case: IV In the case the observer is stationary and source is moving away from the observer with velocity 'V'. Hence the position of the source is constantly changing by a distance 'VT' in time interval 'T' results a displacement of 'VT' away from the observer during the emission of two successive corpuscular spheres. Due to this displacement of source all the properties of the radiation with respect to observer are reorganized. Therefore the apparent time interval with the observer receiving corpuscular spheres is

$$T_{IV} = T - \frac{v}{\lambda}$$

Hence the apparent sphere frequency 'ν_{IV}' is

$$v_{IV} = v \left[1 - \frac{v}{C} \right]$$

The apparent sphere distance ' λ_{IV} ' is

$$\lambda_{IV} = \lambda \left[\frac{C}{C-v} \right] \text{----- (4)}$$

There fore the swift in the sphere distance is

$$\Delta\lambda = \lambda \left[\frac{v}{C-v} \right]$$

The Equations in case I and case II and case III and case IV are exactly equal hence the Doppler Effect is symmetrical.

References

- [1]. The theory of heat radiation. Max Planck Dover publication.Inc. Newyork 1959.
- [2]. A. Einstein. Ann.d.Physik 17,145,1905.
- [3]. W.Dvane; F.L.Hunt. Phys.Rev 6, 166,1915.
- [4]. E.G.Dvane, Palmer,Chi-sun-yeh. J.Opt.soc.Am. 5,376,1921.
- [5]. N. Bohr. Phil. Mag 26,1,476 and 857,1913.
- [6]. C.T.R.Wilson. Proc.Roy.Soc A104,1,1923.
- [7]. F.W.Bubb. Phy.Rev.23,137,1924.
- [8]. Eg.Auger. Comptes rendus 178,1535,1924.
- [9]. D.H.Loughridge Phys.Rev 26,697,1925.
- [10]. F.Kirchner Zeits f physic 27,285,1926
- [11]. E.J.Williams Nature 121,134,1928
- [12]. N.Bohr; H.A.Kramer; J.C.Slater. Phil.Mag 47,785,1924.
- [13]. W.Bothe Zeits.f.Physik 16,319.1923 and 20,237,1923.
- [14]. A.H.Compton; A.W.Simon. Phys.Rev 25,306,1925
- [15]. A.A.Bless. Phys.Rev 30,871,1927
- [16]. W.Bothe. Zeits.f.Physik 37, 547,1926.
- [17]. W.Bothe; H.Geiger. Zeits.f.Physik 26,44,1924.
- [18]. A.H.Compton; A.W.Simon. Phys.Rev 26,289,1925.
- [19]. L. De Broglie. Phil. Mag. 47, 446, 1924.
- [20]. Otto Stulman. Phys Rev 20(1),65,1922.
- [21]. David W.Cornelius Phys Rev. 1(1),16,1913.