HOME

The Nature of Light

A Unified Theory of Rotating Electromagnetic Dipoles

by

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Summary

A new theory is proposed which encompasses both the particle and the wave behaviour of light. The basis of the theory is that light consists of rotating electromagnetic dipoles which are ejected by the bonds between particles. The dipoles are generated in the medium of space by the known process of induction as a result of the movement of the electrons in the bonds. This eventually causes them to reach an unsustainable energy level, at which a dipole is ejected. This is the electromagnetic activation energy for the bond,

The energy of the dipole is contained in its rotation, which is specific to the type of bond which gave rise to it. Dipole energies are therefore quantised. Rotation of the dipole also provides it with a frequency. The rotation of dipoles in three dimensions provides an explanation of plane polarisation.

Dipoles travel in straight lines at the speed of light until they are absorbed by particulate structures, and turned back into bond vibrations by the reverse of the above process.

A dipole behaves like a particle, because it is a discrete entity. The separation of charges provides a mechanism of deflection, apparently round corners, which simulates wave action when like charges come into positions of coincidence. These deflections are produced by orbital interactions, not a mechanical collision mechanism. These properties are shown to account for the observed diffraction by pinholes and gratings in an analysis which is parallel to that of the wave theory.

Tests are proposed to validate the orbital deflection theory. If such a mechanism occurs, the inverse square law may be less applicable than generally believed, especially at long distances.

1. Introduction

A previous paper on The Origin of Quanta (1) put forward the theory that all electromagnetic radiation consists of point disturbances of determinate energy travelling through a medium, which is the medium of space. The disturbances are ejected into the medium of space by the vibration of bonds between particles, when the bonds acquire more energy than they can sustain. The theory is elaborated further in a second paper, The Definitions of Physics (2).

The hypothesis, therefore, was that there exists a medium which permeates all space including that between particles right down to the most fundamental, and which can accept electrical and magnetic vectors i.e. electromagnetic phenomena. This is simply an extension of the known properties of materials, which are in effect particles both pushed apart and pulled together in a balance of forces to form spatial structures. It is certainly established that materials can support electrical and magnetic vectors.

In this model, therefore, the physical world is considered to be decomposed into two categories: either particles, which can be neither created nor destroyed but only rearranged, or electromagnetic radiation which the particle structures throw off into the medium of space when they become overexcited. Defined particle structures would give rise to determinate disturbances travelling through the medium of space, and these eventually meet other particle structures and cause oscillations, which we interpret as light of different shades and colours.

These light disturbances are neither particles nor waves. They are in effect quanta of energy being transported from one particle structure to another through the medium of space. They do not have the dimensions associated with the concepts of waves, nor even photons, whence their description as point disturbances.

However, the present paper suggests that they have dimensions associated with rotation. It proposes that they be considered as progressive, rotating, electromagnetic dipoles, which provides sufficient scope to encompass both the types of observed phenomena that point towards a dual nature of light.

The analysis begins by examining the wave and particle theories of light.

2. Current Views on the Nature of Light

The wave theory of light seems to explain the phenomenon of diffraction. Waves can be made to overlap geometrically to produce the same sort of effect as can be seen on the surface of water. Peaks coincide to produce an even higher peak, troughs coincide to produce an even lower trough, and where peaks and troughs coincide, they simply cancel each other. The same sort of pattern can be observed with coherent light.

There are, however, some questions to be asked about such an analogy. In water each wave is connected to the wave immediately following it. In addition, the existence of a wave front means that each point on a wave crest, for example, is connected with the point adjacent to it. If you were riding on a point on a wave crest, you would be able to see all this for yourself.

Light is said to be a progressive transverse wave, because the electromagnetic oscillations are in a plane perpendicular to the direction of travel. However, we are talking not about interacting particles but about electrical and magnetic vectors. If you were riding with a light wave, what you would know would be the magnitude of, say, the electrical vector at a particular instant. Since you have memory and perhaps a notepad and a watch, you would be able to ascertain that this magnitude varied sinusoidally with time. But it would be no use looking back to compare magnitudes of waves, because there is nothing behind; the point on which you are riding is the only one of which you can be aware. The same is true of the wavefront; it does not exist. It may be convenient to regard the light as a long string, where everything is attached to everything else, but it is not in fact connected, either longitudinally or latitudinally.

Light represents electromagnetic energy, but energy does not turn itself on and off like the electric vector; it must be present throughout the journey until it is dissipated, simply on the grounds of conservation. Assuming the energy of the light is a function of the magnitude of the electric vector, when points of equal electric vectors coincide, the energy at the point of coincidence must double. What happens if they are not equal? Fractional increases in energy would contravene current theories.

Furthermore, when points of equal and opposite electric vectors coincide, they cancel each other out, and the result is darkness. What happens to energy then? Does it disappear, and if so, by what mechanism? It cannot be transferred along the wave front, because as pointed out above, there is no connection.

There is similar set of questions if light is considered to be a stream of photons. The energy of a photon is proportional to its frequency, the constant of proportionality being *h*, Planck's constant. Planck concluded from his study of black body radiation that light energy is emitted from particulate structures at discrete levels, which he called quanta, and that the energy of a quantum is proportional to the frequency of light emitted. Hence his constant of proportionality.

Einstein extended the concept of Planck's quanta of energy to their progress through space. His hypothesis was that a quantum was a particle of light, because particles were necessary to explain the photoelectric effects which occurred at receptors of the light. The sequence of the logic was: Planck had shown that light energy was emitted as quanta; light energy had effects on receptors which required that light should be acting as particles; therefore quanta of light must take the form of particles when it travels through space. He coined the term photon for a particle of light travelling through space. Each photon was a defined quantum of energy, and had to have a defined wavelength or frequency in accordance with Planck and photoelectric measurements.

The photon hypothesis is quite different from the interpretation of light as waves, and translation of ideas from one model to the other produces some difficult questions. For instance, what happens if two photons coincide? Do they add together to form a particle with twice the energy, and so twice the frequency at half the wavelength? Do they annihilate each other if they are out of phase? In which case, what happens to the energy, because it must be conserved?

Whereas a wave theory of light can provide an explanation for polarity and the phenomenon of polarisation, how can this be reconciled with the characteristics of a photon, which carries no distribution of charges or structure which would provide a possible explanation?

There is, however, a further problem in the form of the inverse square law. It can be appreciated instinctively that waves would diminish in intensity with the square of the distance travelled; the wavefront is just spread out geometrically. But what happens to a photon when it travels through space? By definition there is no characteristic in the concept of a photon which can diminish progressively, let alone with distance travelled. There is nothing in a photon which represents light intensity, as opposed to frequency or energy, which in any case are considered to be given.

The result is that the two theories are treated as different models for different purposes; any reconciliation is mathematical. However, there must be some underlying physical commonality, which allows light to behave either as waves or as particles at a receptor, because there is no reason to believe that light knows it has the choice.

Part of the difference lies in the scale of light under consideration in a particular measurement. The observer is interested in either the isolated 'particle' of light or in the bulk phenomenon, and the models have been framed with this in mind.

It all bears a striking resemblance to the difference between a whole system and its parts, and the following model continues this line of thought. It suggests that the reason for the apparently dual behaviour lies in the most fundamental characteristic of systems: the interaction of its parts.

3. A Theory of Rotating Electromagnetic Dipoles

Rotating electromagnetic dipoles may form the basis of a new theory which begins to bridge the gap between particle and wave theories as follows.

Excitation of a bond at the level of atomic particles means that the electrons which form the link are charging up and down ever more vigorously. If there are particles A and B, the bond might be considered as in Figure 1, where the dotted line represents the movement of electrons.

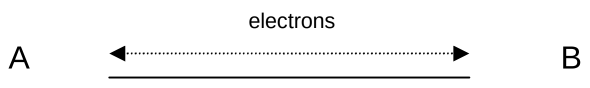

Figure 1. Bond between Particles A and B

The hypothesis is that the movement of electrons gives rise to a local disturbance in the medium of space by the known process of electromagnetic induction. The flow of electrons along the bond between A and B generates what is in effect a circular electric current. The circular flow of current around the disturbance represents a separation of charges between the centre and the periphery, which can be represented as a rotating electric vector (Figure 2).

The orientation of the circular flow may vary after separation from the bond to create what is in effect a spherical shell, which gives a structure analogous to that of an atom. The negative shell prevents the disturbance from merging with other such disturbances.

The same process generates a magnetic field around the bond *AB*, perpendicular to the flow of electrons, which gives the charged sphere a thrust out into the medium of space.

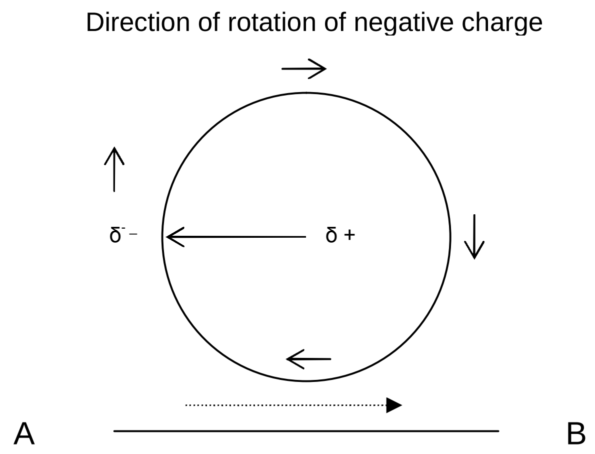

Figure 2. Formation of a rotating electromagnetic dipole

At a particular energy level of excitation, which may be called its electromagnetic activation energy, similar to the term used to characterise the resistance to the formation of chemical bonds, the bond ejects the disturbance, and returns to its ground state. The electromagnetic activation energy and the quantity of energy emitted would be characteristic of and unique to that type of bond.

This is consistent with Planck's conclusion that energy was emitted in discrete quantities which he called quanta. If this is the sort of process which occurs in the emission of electromagnetic radiation, the result is:

- A discrete entity is created in the form of a rotating dipole which may be conveniently represented by a sphere. This entity is a quantum.

- The sphere has in effect a charged shell which maintains its integrity in proximity to other charged spheres.

- The sphere has frequency in the form of the rotation of the electric vector. The number of rotations per unit time is the frequency of the emission.

- There is a notional dimension of the sphere in the form of the distance implicit in the term separation of charges.

- A determinate quantity of energy is transmitted, since it depends entirely on the period of vibration of the *AB* bond. This accords with Planck's quantum theory.

- The direction in which the dipolar disturbance is ejected will depend on the orientation of the *AB* bond, though it may not be perpendicularly up from the ‘bowstring’ linking the two particles in the diagram. It may in fact be perpendicular to the plane of the page because of magnetic repulsion.

- If the number of bonds were large enough, which is the normal situation, electromagnetic disturbances would be emitted in all directions at random. This is the candle effect.

- The time at which any particular bond emitted a quantum would depend on the conditions in its locality, and so for the bulk material it would be in effect random.

- The velocity of all such electromagnetic dipolar disturbances through the medium of space would be the same irrespective of the frequency of rotation of the electric vector. It would depend only on the electromagnetic characteristics of the medium of space.

- The electromagnetic characteristics of the medium of space would also set the limiting value, the speed of light.

- There is no reason to think that such an electromagnetic dipole would travel in anything other than a straight line in vacuo.

- Electromagnetic dipoles rotating in this way have both the energy and the frequency of vibration to regenerate vibrations in a receptor of the appropriate frequencies when they come into contact with particulate structures after transport through the medium of space.

- How effective the ‘shell’ is as a protector of the entity may depend on frequency. Higher energy, and hence higher frequency, may make a more impenetrable shell.

- There is no loss of energy from such an electromagnetic disturbance during transit except to the medium of space.

- Such a loss of energy would manifest itself as a reduction in the rate of rotation of the electric vector i.e. reduced frequency.

- Some loss of energy in transit may be necessary for the bonds of the particle structure of the receptor to accept it instead of passing it straight on.

It is the vibration of the bond *AB* which imparts velocity to the electromagnetic sphere for its transit across space i.e. the speed of light. It may be that the ‘geometry’ of the sphere, which is essentially the size and degree of separation of charges, compensates by some electromagnetic mechanism to ensure that its velocity through space remains constant for different rates of rotation of the vector i.e. different frequencies. Energy in the spherical disturbance would depend on the frequency of rotation of the dipole, which is consistent with Planck’s quantum theory.

The overall effect is to turn heat into bond vibrations, and bond vibrations into electromagnetic radiation which is transported through space. The process is reversed when the radiation meets and interacts with another particulate structure, the receptor, and causes bond vibration and hence heat – a redistribution mechanism.

The phenomenon of polarisation is accommodated in this model by the sphericity of the electromagnetic disturbance.

As the sphere travels in, say, the direction of the *x*-axis, the dipole rotates, and the negative charge describes a wave which is sinusoidal in three dimensions. In addition the axis of rotation of the dipole can vary in orientation as the disturbance moves forward. Unless there is some characteristic of the bond to prevent it rotation raises the possibility of two types of 'helical' motion: dextrorotary and laevorotary. This would produce two species of sphere which could never become identical, though it is not clear that this would make any difference to a receptor. The origin of this asymmetry is the direction of movement of the electrons along the bond *AB* at the instant when the sphere formed, and hence the direction imparted to the circular electric current.

Polarisation occurs when light is transmitted through certain types of material. In this case the three dimensional rotation of the dipole would in effect be constrained to two dimensions; the sphere would be compressed to a circle, perhaps by absorption of components in one of the dimensions. The path of the negative charge would then be a pure sine wave within the *xy* or *xz* planes. The two opposing directions of the initial circular electric currents would give identical sine waves 180° out of phase.

Thus there could be three species of sinusoidal wave described by a negative charge in this model: dextrorotary and laevorotary in three dimensions and the simple planar sine wave. This would add a new dimension to the question of coherence, and it would certainly affect the outcome if such electromagnetic disturbances came into coincidence. What is clear is that electromagnetic vibrations polarised in this way could not be reconstituted into their original form by mixing them, because there is no way of reintroducing the random three-dimensional element.

Polarisation is also produced by reflection at a surface. In wave theory vibrations are said to be resolved into two components, one which is absorbed and the other which is reflected as a plane polarised wave. The same argument could be applied to the new model, and similar reasoning could account for the phase change on reflection.

The problem then is to reconcile the model of progressing, electromagnetic dipoles which rotate in three dimensions with the observation that light can apparently travel around corners.

4. A Deflection Mechanism

The proposal of this paper is that when rotating electromagnetic dipoles come into a position of coincidence, they deflect each other. The essence of the model lies in the forces of attraction and repulsion between dipoles, which result from the separation of charges on individual dipoles. Systematic coincidences deflect dipoles which may accumulate in geometrical patterns. These accumulations produce enough change in intensity for us to observe e.g. as diffraction.

Dipoles originating from a notional point do not meet, because they are radiating outwards away from each other. But they do not meet even if they are travelling in the same direction, because they are emitted separately and travel at the same velocity.

However, the only real point source of light is an individual bond, as in a single atom. All other sources of emission have bulk dimensions perpendicular to the line of travel of light, which are significant enough to cause the paths of a proportion of the emitted electromagnetic dipoles to coincide at some point, before they meet an absorber in the form of another particulate structure. So the Sun has a significant diameter for those on Earth, and a lamp filament in the laboratory has a length. Even when steps are taken to form a narrow beam of light with slits etc, any phenomena resulting from the dimensions of the original source may persist for at least part of the journey.

If the paths along which the rotating dipoles travel are arranged so that coincidences occur, they may deflect each other. This is particularly likely when they are travelling in opposite directions on the same track No energy is lost during the encounter, rather like a perfectly elastic collision. However, although it is convenient to consider them as spheres, and represent them on paper as circles, rotating dipoles are not billiard balls; the laws of mechanics do not apply. Hence the use of the term “coincide” instead of “collide”.

Deflection occurs when the charges on two dipoles coincide in alignment, or sufficiently so to repel or attract each other. Thus there are two possible mechanisms at work. First, the dipoles may repel each other if their paths cross because their negative charges are opposed at the instant of coincidence. They then continue on new paths at equal but opposite angles to their original directions, equal on grounds of energy conservation. Since red is observed to be deflected more than blue in diffraction, some kind of orbital mechanism seems to be at work.

This might be easier to envisage with the second mechanism, which concerns attraction. This would occur when the negative charge of one dipole was in proximity to the positive charge of the other at the instant of coincidence, so that there was an attraction between them.

The ‘spheres’ would not merge but enter into each other’s orbits briefly in passing, like incipient twin stars, and they would then both be ejected at equal angles to their original paths. Higher frequency rotating dipoles would seem to interact less than lower frequency rotating dipoles. The low frequency dipoles would be able to penetrate further into each other’s orbits, and get a greater ‘slingshot’ effect, with the result that they would deflect each other more.

This would be analogous to electrons and other charged particles penetrating atomic structures.

This is set out in Figure 3. Arrows within circles represent the electric vector.

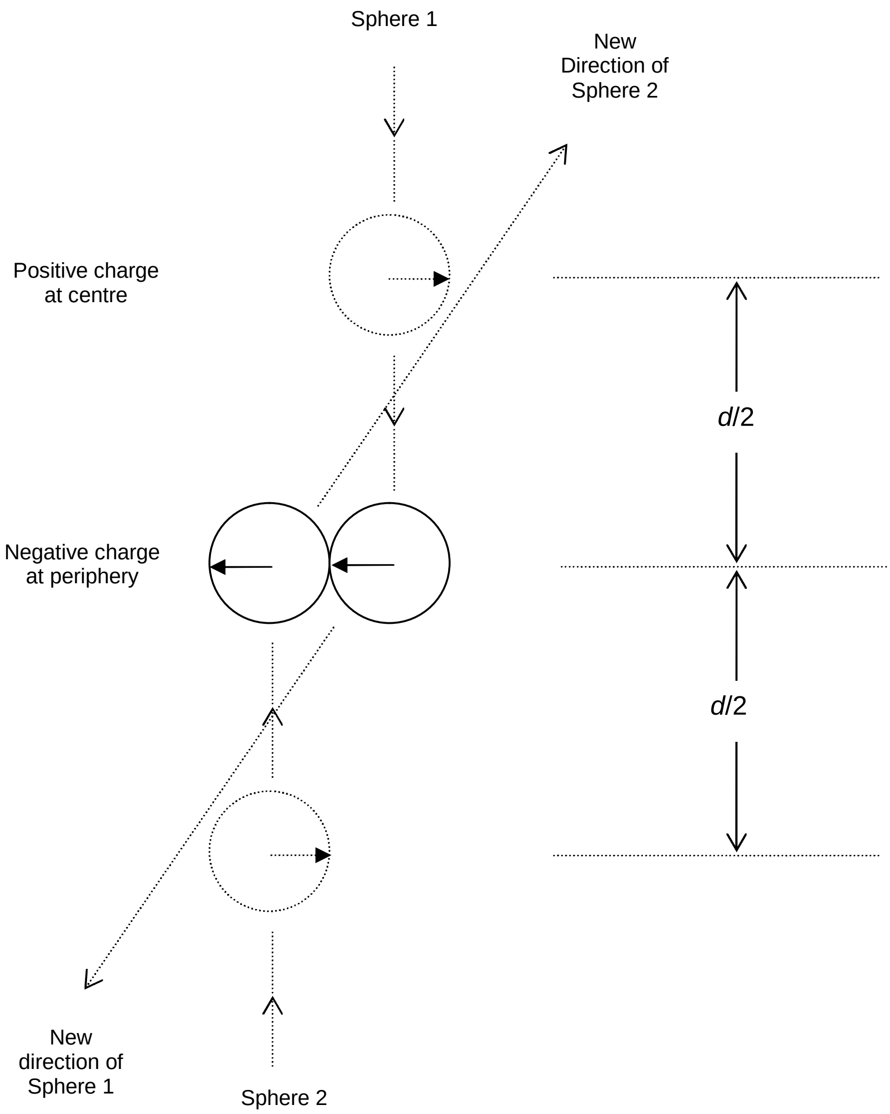

Figure 3. Orbital Interaction of Two Electromagnetic Spheres Approaching from Opposite Directions

A measure of distance is required to demonstrate the change in dipolar orientation as they approach. There is no wavelength as such, but there is a convenient measure of distance *d* which is the distance travelled while rotating electric vectors make a complete rotation.

Spheres 1 and 2 approach each other from opposite directions. Their dipoles have the same orientation when they coincide. The spheres are attracted enough by the proximity of the negative charge on Sphere 1 to the positive charge on Sphere 2 to swing round each other and set off in new directions at the same angle with respect to the original directions.

All this can take place in three dimensions, and in fact the two mechanisms may be the same process for practical purposes, whatever coincidence is needed to produce the orbital deflection effect. The following analysis assumes that the principal mechanism is the repulsion of negative charges.

5. The Bending of Light Around Corners

The deflection process explains why light which consists of discrete quanta travelling in straight lines can apparently bend around corners.

First the emitter has bulk dimensions, which means that it presents an area to the path of the light. Light is emitted in all directions at random from every point on the area, so that the paths of some of the rotating electromagnetic dipoles will coincide in transit to the receptor. The very large numbers of dipoles ensures that the opportunities for such coincidences persist along the path of the light. The process will come to an end only when all dipoles with a component of velocity at an angle to the mainstream have been deflected out of the way of the other dipoles, so that the chances of coinciding among those that remain are reduced to zero. There will be a geometrical relationship between the paths before and after deflection.

The receptor must also have dimensions, if it is to have any chance of receiving the light. Some light will be reflected from the effective area which it presents to the direction of the beam. Reflected dipoles may then interact with oncoming dipoles, which will cause more deflections. There will be a geometrical relationship between the directions before and after deflections as in Figure 3.

All this will be occurring between any source of light and its receptor.

However, if the receptor surface were pierced, say by a circular hole, the beam of light would travel through the hole and might be viewed by a telescope. If all the dipolar spheres were to travel in parallel straight lines, the telescope would see just an illuminated disc. But if a proportion of dipoles were on divergent paths as they passed through the hole as a result of the process of deflection by coincidence, they would fall outside the area of the disc by a distance determined by the angle of deflection.

If the circular hole in the receptor was large, the edge effect would be many orders of magnitude smaller and much less bright than the central disc, and so it would not be observable. However, if the circular hole were very small, there would be much more edge compared with the area of the hole. The same edge effect would occur, and fringes of light would appear on the unlit background at the predetermined angles, outside the bright disc, in the form of bright circles resulting from the circular shape of the disc. The separation of the circles would depend on the angles inherent in the orbital deflection of dipoles, which is characteristic of their frequency.

The process depends on the probability of coincidence of the moving, rotating dipoles. The angles of deflection depend on the frequency of the rotating dipoles i.e. the colour which they represent to a receptor. However, these are only the most probable coincidences and outcomes. There is no reason why dipoles of different frequency should not coincide. It is simply that their probability of interacting electromagnetically i.e. through their charges will be that much less than for identical dipoles. Moreover, there is no reason why dipoles, whether identical or different, should not interact at different angles of rotation i.e. they do not have to be opposed or in phase to influence each other, but the coincidences are much less likely to occur. The outcome will be a whole population distribution of angles which occur less frequently.

The result is that there will not be a single clear angular displacement from such a process. There will be the main displacements, which have the greatest intensity, resulting from the most frequent i.e. likely coincidences. These will be flanked by broader distributions of lower intensity representing the distribution of lower probability coincidences.

This is what is in fact observed in the phenomenon of diffraction.

6. Phasing of Interacting Dipoles

The term "phasing" is used here as the comparative state of a repetitive process at a particular instant of time. This definition can be applied to electromagnetic dipoles which are separate entities and travelling on different paths. If they are repeating the same frequency, then the same phasing will occur at the instant when they coincide, wherever they are coming from. The rotation of dipoles travelling at the speed of light means that their negative poles describe a helix through the medium of space. The following analysis applies to dextrarotary helices of the same frequency.

When two such dipoles travel towards each other on parallel paths, close enough for them to interact i.e. 'collide', the negative poles interact only if they are 180° out of phase. This is the phasing at which the poles come closest to each other. This is consistent with the condition of wave theory that light must be both of the same frequency and in phase for interference to occur, because production of one of the helical paths by reflection would cause it to change phase by 180°.

The assumption is that phase change does not turn it from dextra into laevorotary, but only that it sets back or advances rotation of the dipole by 180° in the same direction of rotation.

Similarly, when dipoles travelling in the same direction are converging on paths which are not quite parallel, they need to be 180° out of phase for negative poles to interact. In this case dipoles which are in phase initially will be 180° out of phase when the paths along which they have travelled differ by a distance $d/2$ in Figure 3.

These are the two limiting cases when the chances of coincidence of the negative charges is greatest.

Both types of coincidence give the same angle of deflection, which is produced once they have interacted, because it is an orbital rather than mechanical phenomenon.

7. Angles of Deflection

The proposal is that each deflection adds a velocity *v* to a dipolar sphere perpendicular to the straight line joining the centre of the source to the centre of the receptor. Dipolar spheres coincide with others which are 180° out of phase to give a deflection of angle θ_1 to the direction in which light is travelling. Those which have been deflected, may be deflected a second time by coincidence with another dipolar sphere travelling in the opposite direction etc. The velocity of all dipolar spheres remains the same, the speed of light, before and after deflection. The result is shown in Figure 4.

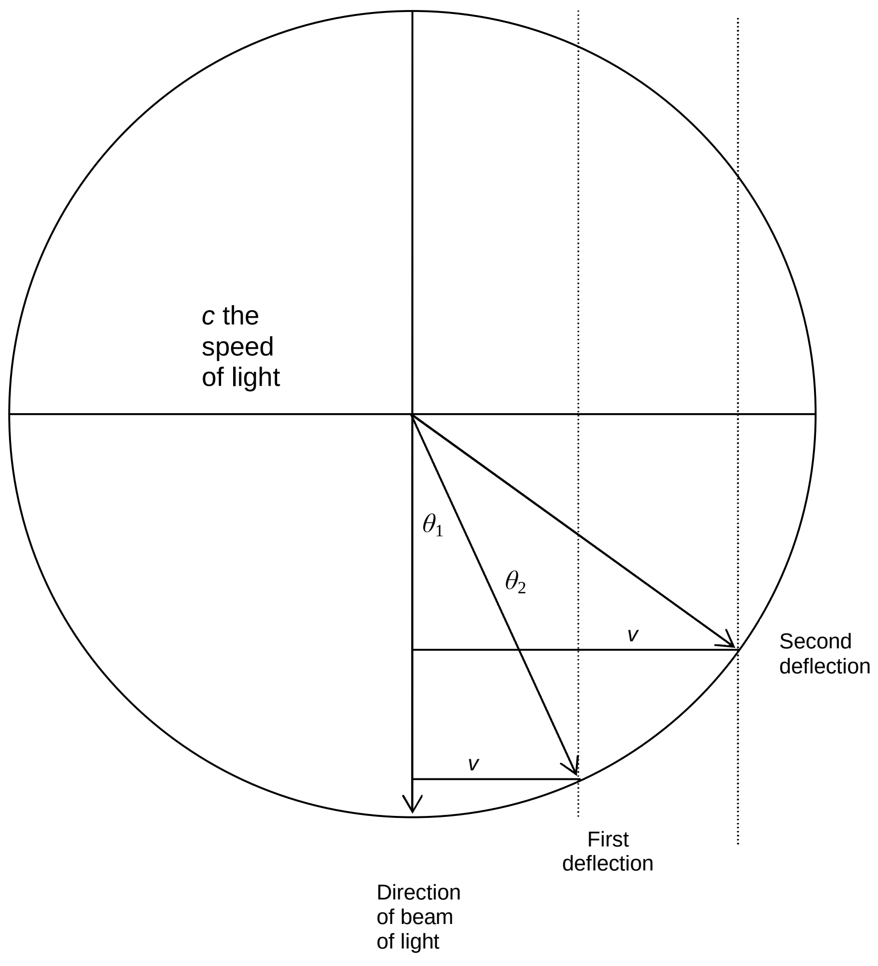

Figure 4. Angles of Successive Deflections of Rotating Dipoles

From this it can be seen that:

$$\sin\theta_1 = \frac{v}{c}$$

$$\sin\theta_2 = \frac{2v}{c}$$

.
.

and

$$\sin\theta_n = \frac{nv}{c}$$

where c is the speed of light. The limit imposed on θ by this mechanism is 90°.

8. Diffraction Gratings

A diffraction grating is a receptor in the form of a thin opaque film on which the diffracting pinhole has been drawn out to form a very narrow slot through which light can pass. The grating consists of many such many such slots parallel to each other, regularly spaced and separated by wider, opaque sections of the film itself which have not been removed. The closer the slots, the greater the relative edge effect, described above. In wave theory terms, the spacing should be comparable to the wavelength of light which the grating is used to diffract.

If a beam of monochromatic light passes through the grating, each slot produces a well defined diffraction pattern. If the slots are close, bright bands, called lines, are produced which can be observed at well defined angles symmetrically on both sides of the incident beam, when brought together in the focal plane of a lens.

Let the distance between the centres of adjacent slots be s, and let lines be observed at angles θ_1, θ_2, … θ_n, when brought together in the focal plane of a lens.

The reasoning of wave theory is as follows:

- Light is a wave motion, and so it has a wavelength.
- The wavelength λ is the distance travelled by light between peaks.
- The wavelength determines the angles through which light is refracted.
- If rays of light from different slots form a bright line when observed with a telescope, it is because their paths differ in length by a whole wavelength, so that their peaks reinforce.
- The first bright line therefore corresponds to a difference of λ, which is called the first order diffraction image. The second band corresponds to 2λ, which is the second order diffraction image, the nth bright line corresponds to $n\lambda$ and so on. This is set out in Figure 5.

- From this the relationship:

$$s \sin\theta = n\lambda$$

can be derived.

- For the first bright line $n = 1$, and so

$$\lambda = s \sin\theta$$

from which λ can be calculated.

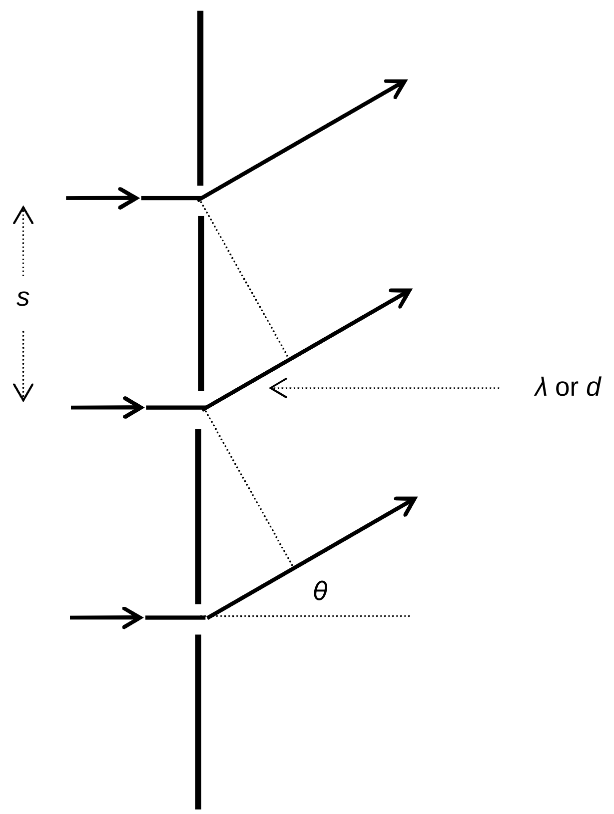

Figure 5. The Relationship between Diffraction Grating Spacing *s*, the Angle of diffraction *θ* and the Distances *λ* or *d*

The corresponding reasoning for the rotating electromagnetic dipole theory is as follows:

- Light consists of progressive, rotating electromagnetic dipoles.

- The frequency of light *f* is the frequency of rotation of its dipoles i.e. the number of cycles per second.

- Frequency determines the angles through which light is refracted.

- The distance *d* in Figure 3 is the distance a dipole travels between the same points in the cycle i.e. in phase.

- Bright lines are produced when dipoles are in phase.

- The first bright line corresponds to the first orbital deflection, the second line corresponds to the second orbital deflection, the *n*th line corresponds to the *n*th orbital deflection etc.

- From this the relationship:

$$s\sin\theta = nd$$

can be derived.

- The *n*th deflection produces an angle θ_n such that:

$$\sin\theta_n = n\sin\theta_1$$

from which sin θ_1 can be calculated.

- From the equation, when $n = 1$, $\theta = \theta_1$ and

$$d = s\sin\theta_1$$

from which *d* can be calculated.

- The frequency of the light is then the velocity divided by the distance *d*.

9. The Inverse Square Law

This law states that the intensity of light is proportional to the inverse of the square of distance travelled. It is one of the most fundamental principles of the physics of light, and it is accepted as a fact of life. However, the question may be asked: what is its theoretical underpinning?

Light from a candle can easily be understood to follow an inverse square law. Light emitted at any instant spreads out in all directions at the same speed, which suggests it forms a spherical surface, centred on the candle. The area of the spherical surface would be proportional to the square of its radius, which is the distance from the candle. Hence the same amount of light would be spread out ever more thinly over a surface which grew with the square of the distance.

It is not quite so obvious why a beam with a smaller solid angle made by shielding most of the light at source should behave in the same way. The assumption is that light in the smaller solid angle does not interact with the light in the rest of the solid angle i.e. the light which would go off in all the other directions, but has been shielded off. It can therefore be treated like a slice out of a cheese which does not affect the rest. Moreover, beams focused by reflectors are thought to behave in the same way.

The concept of rotating electromagnetic dipoles suggests that there may be another mechanism. When a beam is shone through the medium of space, it is accepted that light is seen only by the receptor at its end. What is seen must provide all the information the receptor can acquire. There is no information about what else may be going on, because light cannot be seen from the side.

But if the process of dipole deflection is occurring, it would mean that a proportion of dipoles would be deflected out of the beam all the way along its path. This would be rather like scattering by dust, which is certainly visible from the side, but a different cause. The intensity of the deflected light would be very low, partly because it would be only a fraction of the energy retained within the beam at each stage, but partly because the solid angle surrounding the beam spreads out any light deflected over a much larger area.

Intensity is measured by using light from a standard candle falling on a standard area at a standard distance from the source. Thus if a deflection process is at work, it will already be occurring between the source and the standard area i.e. it is already factored into the measurement, and hence any measurement which is made further down the path of the beam. The measurement provides no information about what may be occurring in the body of the beam or outside the beam, but just what arrives at successive stages of observation.

However, understanding the phenomenon requires a look at the whole system. If the deflection mechanism is at work, light from a candle would still lose intensity as on an expanding sphere, because the deflections in different directions between segments would cancel each other out. Every segment would gain as many deflected dipoles as it lost, and the spherical surface concept of the inverse square law would still hold good. It is only when segments are isolated from each other that the interaction between them may be observed, because this removes the possibility of the transfer of dipoles between segments.

In energy terms, what does not arrive with the beam must be dispersed on its route to the observer. It disappears into the rest of the solid angle, the part which is not being observed. In any case no energy can be lost from the system as a whole. In spite of the low intensity it may be possible to detect energy lost to the beam in this way.

If the proposed mechanism holds good, it raises some fundamental questions about the applicability of the inverse square law to light concentrated in a segment of the solid angle i.e. a beam of light. At some point, which may be calculable or even measurable, a beam of light may have used up all its internal deflections; all the deflected dipoles would have eventually been deflected out into space. The implication would be that the domain in which the inverse square law was valid would have come to an end. All the remaining dipoles would be on parallel paths.

Thereafter there would be no reason why the intensity of the light of the beam should diminish at all with distance travelled. This would be an exact parallel of the photon theory, which does not envisage any diminution of intensity with distance.

If the intensity of light reaches a constant value at some point, which may be a very long way from its source, it poses some challenging questions for the interpretation of measured intensities of light from stars, for example, and for calculations of their distance from Earth.

This effect is quite different from the diminution of energy with distance implied by the phenomenon of redshift. Conventional analysis links redshift, and hence the energy of the light, to the motion of the star emitting the light, even though it can be argued that this breaches the Special Theory of Relativity.

A previous paper suggests an alternative theory, namely that the light loses energy exponentially on its way through the medium of space (3). Since energy is proportional to frequency, the frequency of light also decreases exponentially, which produces a shift towards the red end of the spectrum. This is quite apart from diminishing intensity, which is the number of dipoles falling on unit area i.e. the behaviour of a population of dipoles rather than a single dipole.

The theory of this paper provides a mechanism by which this redshift could happen; the rotation of dipoles gradually slows down during their passage through the medium of space. This would produce the redshift. It would also imply a mechanism for imparting energy more widely to the medium of space as well as causing a temporary disturbance in it by electromagnetic induction. That would say something about the nature of the medium of space.

Lasers may be less susceptible to the deflection process by the very nature of their production. Less deflection would mean a more concentrated beam for longer distances.

Lasers with no inherent coincidental deflections might go on for great distances until the redshift effect eventually sapped their energy.

10. Tests of the Theory of Rotating Electromagnetic Dipoles

a. Orbital Deflection Mechanism

The hypothesis is that the dipoles reflected from the source-side of a receptor coincide with oncoming dipoles, and are deflected by orbital interaction. Such an orbital deflection mechanism could be tested by directing two beams of monochrome light from a single source directly at each other and looking for deflection patterns.

If the paths of the light were directed by two pairs of prisms, they would arrive in opposition in phase. If, however, one prism was replaced by a mirror, the opposing beams would be out of phase.

The deflection patterns would appear on both sides of the opposing beams (Figure 6).

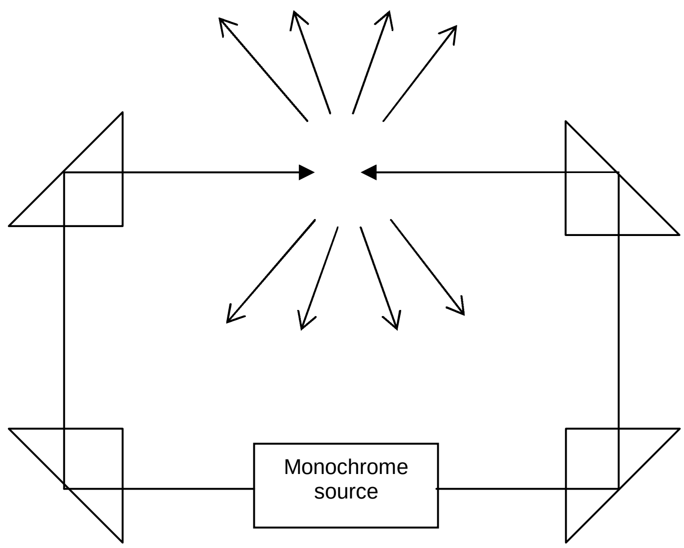

Figure 6. Orbital Deflection Pattern from Opposing Beams

b. Source-side Reflection

If reflection is an important part of diffraction, the intensity of peaks and lines should change with the reflectivity of the source-side of the receptor, both for pinhole diffraction and gratings.

It is already known that partial silvering of surfaces produces remarkable changes in interference, as used in the Fabry-Perot interferometer.

Moreover, reflection should also produce a diffraction pattern behind the source. Such a pattern would be an image rather than a mirror image of the diffraction pattern which is conventionally observed.

The original Grimaldi effect should also be more definite with a silvered wire.

c. The Inverse Square Law

The inverse square law could be put to the test in a number of ways.

i. It might be possible to detect light emitted from the side of a beam in a totally dust-free space.

ii. It might be possible to test the law over astronomic distances by measuring intensities of identical sources in space and on Earth.

iii. It might be possible to model the inverse square law using a variant on collision theory.

d. Magnetic Fields

Magnetic fields should affect both the rate of rotation and the velocity of electromagnetic dipoles i.e. the frequency, speed and direction of light.

It may be possible to align dipoles at the point of emission i.e. at the bond by the application of magnetic fields.

e. Polarised Light

Light polarised in perpendicular planes should be 180° out of phase. It should be impossible to polarise light in the plane perpendicular to the line of travel i.e. the *yz* plane.

f. Velocity of light

The negative charges produced by charge separation describe different paths through the medium of space for different orientations of the axis of rotation of the dipole, even at the same frequency. Some paths will be longer than others, if they have a component in a third dimension.

If it is the velocity of negative charges through the medium of space which is the ultimate limit, dipoles as units may be able to travel faster through the medium of space along the *x*-axis if the total paths of their negative charges are shorter. The ground they cover per second along the *x*-axis, which is the speed of light, may be greater.

Plane polarised light produces different paths from normal light. It is known to have different refractive indices i.e. velocities in double refraction in some materials. The analysis suggests that it might also have different absolute velocities through the medium of space i.e. in ‘vacuo’. This is open to measurement.

In addition, if there are slightly different *x*-axis speeds for different dipole motions, what we know as the velocity of light may in fact be an average.

11. Conclusions

The theory of progressive rotating electromagnetic dipoles contains enough degrees of freedom to explain the observed phenomena of light, whether they suggest particle or wave behaviour. It may also shed light on polarisation.

Such dipoles are reminiscent of Newton’s corpuscles of light, though they differ substantially from Einstein’s photons. It is their separation of charges which give rise to deflections and offer an explanation of wave effects. It is their rotation which gives them a frequency in accordance with Planck's quantum theory. They are rather like electromagnetic atoms.

The deflection process depends on a mechanism which is similar to the interaction of orbits. In effect it appears to make each new geometrical opening a new source of deflected light, which accords with Huyghens' theory of light waves, secondary sources etc. It also uses the concept of a medium of space, which he considered an integral part of his theory.

The broadening of spectral lines from gases is conventionally attributed to the kinetic movement of emitting molecules, though how this movement can affect wavelength is not clear, again in view of Special Relativity. The suggestion here is that it is simply caused by the length of the bond *AB* at the instant of emission varying under the stimulation of temperature, which may give the same result.

Beat frequencies, which are considered to be evidence of waves, may be accounted for in the dipole theory by locating the effect, which is all that can be observed, at the receptor. Receptor bonds which do not accept a mixture of two sorts of dipoles with different frequencies, may resonate with the difference if both arrive together.

Nevertheless, the dipole theory is consistent with the discovery of Newton that white light acts as a mixture of colours, and that it can be reconstituted from its parts without change after prismatic separation. Dipoles of different frequencies simply find it difficult to interact.

Finally, a rotating dipole theory of light would suggest that magnetic fields could have an effect both on the rate of rotation of the dipole and on its velocity through the medium of space. However, though it may be possible to slow down light, which is after all what happens in a transparent material, it will not be possible to increase its velocity beyond the speed of light in vacuo.

Materials limit the speed of light through the action of their particle structures and the nature of the bonds between them. In the same way the medium of space limits the speed of light by its inherent characteristics, which are not susceptible to change.

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