Coulomb's Law is the Basis for Radiation Energy

Jan Olof Jonson
stmarkstagen 50, SE-12342 Farsta, Stockholm, SWEDEN
e-mail: jajo8088@student.su.se

In this paper it is shown, how the energy due to electromagnetic radiation, thus far derived using the Poynting vector, can be explained using a strictly classical interpretation of Coulomb's Law. The result was achieved using earlier discoveries by this author concerning the electromagnetic force between electric currents and the effect known as electromagnetic induction. In this case the sending current corresponds to the orbiting electron and the receiving current to the current due to electromagnetic induction by a changing electric field in an antenna. The fact that an orbiting electron does not collapse into the nucleus of its parent atom has thus far been considered a major obstacle to a classical interpretation of the behavior of orbiting electrons.

In earlier papers (briefly recalled in this paper) by this author it is has been convincingly shown that a classical particle model is still capable of explaining the eternal, circular movement of an electron around a nucleus. It is possible through the usage of Coulomb´s law in its original classical formulation. In this connection it has also been shown how the radiation due to the de-excitation of an electron can be explained classically. A mathematical model based on the product of a Dirac function multiplied with a sine wave was used. This made it possible to give the "wave-particle paradox" a mathematical basis.

1. Introduction: Coulomb's Law Explains Force between Currents and Induced Currents

In an earlier paper it has been convincingly shown that Coulomb's law is able to account for the electromagnetic force between currents [1]. This was possible by correctly exploring the impact of retardation, both at the 'sending' current and at the 'receiving' current. The retardation effects on a Coulomb field namely bring about a difference in strength between the force due to the moving electrons and the immobile positive ions of a conductor. The mathematical analysis that followed reveals that Coulomb's law when applied to two currents in conductors is proportional to the two currents. Applying Coulomb's law in that way, by properly taking into account the effects of retardation, later lead to the appearance papers explaining, how a photon could be described in a classical way, as a dip in the Coulomb field during the stage of de-excitation between two orbits around a nucleus [2-4]. The close study of a spiral orbit of an electron being de-excited, lead to the discovery that there will arise a net Coulomb field from the collapsing electron. The main final result was the conclusion that the mean value of the total Coulomb field from the atom, having this orbiting electron, will differ from zero. Hence, the field is not zero, contrary to the fact that the sum of the positive and negative charges of an electrically neutral atom is zero. In this paper the analysis is further developed in order to study, how the Coulomb field will act with respect to time, and, accordingly induce an electric current at an antenna. In this connection earlier studies of electromagnetic induction will be used [5, 6].

2. Analysis of the Time Dependence of the Distance Vector

In the papers [2-4] a figure was used in order to describe the orbit of a collapsing electron, simultaneously giving the necessary geometrical definitions in order to succeed. As may be observed, however, the assumption that the 'big distance', that between the atom and the observer, is approximately the same during the revolution of an electron, makes it impossible to exactly determine the time differential of the Coulomb field, which is crucial to know, if one wants to determine the magnitude of the current that will be induced in an antenna. The knowledge of the magnitude of the current is in turn necessary if wanting to determine the Coulomb force on it due to the orbiting electron. Here it is felt necessary to recall the earlier statement above that "Coulomb's law when applied to two currents in conductors is proportional to the two currents".

The distance between the orbiting electron and the point where the fields are being derived would now preferably read

$$R = f\left(t - \frac{R}{c}\right) \tag{1}$$

Coulomb's law in the case of currents in conductors obeys [1]

$$\frac{d^2\vec{F}}{dx_1 dx_2} = \mu_0 I_1 I_2 \cos\theta \cos\psi \frac{\vec{R}}{4\pi R^3} \tag{2}$$

The definition of the variables of this expression is deliberately omitted here, while it has already been made in the cited paper [1]. The crucial matter here is only to recognize the dependence of the product of the two currents, since the electric field basically equals the Coulomb field divided by the second charge and the induced current.

3. The Relation between Energy of Radiation and Coulomb's Law

In the preceding section it was mentioned that the electric field is basically proportional to Coulomb's law. In order to attain an expression for the radiation energy at a distance from the emitting atom, it is crucial to define how the energy is to be derived. One way to estimate it would be to use the concept of electric effect. The effect that is developed in a physical conductor with some degree of resistance is basically proportional to the square of the electric current:

$$P = \frac{{I_2}^2}{\mathrm{Re}} \tag{3}$$

Re here denoting resistance

The induced current in turn is related to the electric field according to [5, 6]

$$I_2 \propto \frac{\partial E}{\partial t} \tag{4}$$

Regarding the effect that is being induced at a 'secondary circuit', more practically in the shape of an electric antenna,

Using now Coulomb's law and the statement above concerning the electric field, one attains

$$\frac{\partial E}{\partial t} \propto k \frac{\frac{\partial I_1}{\partial t} I_2}{R^2} \tag{5}$$

In the case of an orbiting electron in a shell around an atom, the current I_1 corresponds to the circular movement around the atom. At the observation point that would be described mathematically using the approximation

$$I_1 = k_1 \cos\omega\left(t - \frac{R}{c}\right) \tag{6}$$

Using also $\cos(a+b) = \cos a \cos b - \sin a \sin b$ (7)

gives the result

$$\frac{\partial I_1}{\partial t} = -k_1\left(\sin\omega t \cos\frac{\omega R}{c} - \cos\omega t \sin\frac{\omega R}{c})\right) \tag{8}$$

which after usage of series expansion of the sine/cosine functions gives for practical purposes

$$\frac{\partial I_1}{\partial t} = -k_1\left(\sin\omega t - \cos\omega t \frac{\omega R}{c}\right) \tag{9}$$

When surpassing the argument 2π this must be modified, but on a principal level the 'far term' that decreases slowly with respect to the distance, $\propto \frac{1}{R}$, is explained.

Since I_1 is a sine function dependent on time t , $\frac{\partial I_1}{\partial t}$ is basically proportional to I_1 , though exhibiting a phase shift due the interplay between the two terms of Eq. (9) above, one is now able to state about the electric effect P that

$$P \propto \frac{1}{R^2} \tag{10}$$

which allows for the radiation energy to decay $\propto \frac{1}{R^2}$

Since the electric effect corresponds to the energy that per second flows through a unit area, only some geometrical derivations are needed in order to estimate the magnitude of the energy.

4. Comments on Established Electromagnetism

This all has now been done without involving any concepts of Poyinting vector, transverse electric and magnetic field vectors etc, as is the case within established electromagnetism. The direction of the energy vector is in that case attained thanks to the cross product of these vectors. Here, in the case just treated, the direction is from the very beginning given through Coulomb's law. Coulomb's law is straightforwardly obeying the same 'action-along- the vector' principle as gravity.

References

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