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RESEARCH ARTICLE

A Disproof of Einstein's Photoelectric Contention That Maxwell Emissions Are Photons, with an Application to the Resolution of the Wave-Particle Paradox

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Abstract

Albert Einstein's 1905 paper on the photoelectric effect concluded that all electromagnetic radiation consists of particles (photons) with energy $E=hf$. Prior to this, Maxwell's equations on electromagnetic theory were deemed to be the last word on the subject. From these equations Maxwell predicted the existence of electromagnetic waves which travel at the speed of light as given by his formula for c. Both approaches have worked somewhat successfully since then, though arguably not simultaneously. A theory is offered here using mostly classical physics to resolve this wave-particle paradox. In addition to this classical analysis, the theory is further strengthened by a brief discussion of recent works by this author.

1. Introduction

Electromagnetic radiation is generally due either to atomic radiation (AR) or Maxwell radiation (MR). In AR photon emissions arise when bound electrons in atoms/molecules move from higher to a lower energy orbits, whereas in MR the radiation results when free charges undergo acceleration.

In Einstein's [6] 1905 paper on the photoelectric effect he concluded that all electromagnetic radiation consists of particles (photons) having an energy given by E=hf , where f is the frequency. Einstein's theory will be shown here to be incorrect in the case of MR, mostly by way of the classical physics known to him in 1905, but also from recent findings by this author. From the analysis in this work the wave-particle issue will be resolved.

2. An Intuitive Look at the Problem

Einstein's particle theory seems intuitively reasonable when dealing with the bundles of energy emitted by atomic radiation (AR). However, it is quite a different story in the case of Maxwell's radiation (MR), where both the electromagnetic fields and the forces they exert are continuous functions of time. Thus, the question is, how can the resulting radiation caused by MR be discrete? The answer is that it is not discrete.

3. Experimental Evidence Supposedly Corroborating Einstein

Concerning experimental evidence supposedly corroborating Einstein's theory, the problem is that all the lab results which have demonstrated the particle nature of electromagnetic radiation have been based on AR emissions rather than MR emissions. This includes, for example, all the black body studies (e.g., Planck[9]), all the photoelectric experiments (e.g., Millikan[7,8]), all the photon scattering tests (e.g., Compton[5]), and all the Young two-slit anomaly studies which show photon arrivals when the arrival rates are low. The reason for using AR in these tests is that they all either require high energies or low wave-lengths or low arrival rates. MR does not meet any of these requirements, and it therefore has not been used in these experiments. For example,

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photoelectric studies need UVL to overcome the electron work functions of metal surfaces, and even higher frequencies are needed in Compton scattering experiments to penetrate the targets. Accordingly, with the assumption that there is indeed no experimental evidence indicating the existence of photons in MR, the following hypothesis H will now be offered and then analyzed in detail:

HYPOTHESIS H

There are no photons in MR.

4. Example Study #1 in Support of the Hypothesis

Other than the argument that Maxwell's theory seems much more logical than Einstein's theory in the case of MR, further evidence is presented here by way of three example studies to support hypothesis H. In the first such study an example will be given that shows the number of photons per emitting electron per cycle in an antenna can be less than one, which rules out Einstein's theory.

In this example consider a standard electric dipole antenna consisting of two wires of total length D, which are placed in a line and fed by a current generator with D<<λ. Let N be the number of photons radiated per cycle per emitting electron in the antenna. Then:

$$(4.1)\ N = WT / (N_e\, hf)$$

In (4.1) W is the average power radiated per unit time (watts), f is the frequency (Hz), $T=1/f$ is the cycle time, h is Planck's constant, and N_e is the number of emitting electrons in the antenna. It is well-known that the average power output (see, e.g., Slater and Frank[10]) , is given as:

$$(4.2)\ W = u_0 \omega^4 M_0^{\,2} / (12\pi c) = \omega^4 M_0^{\,2} / (12\pi \epsilon_0 c^3)$$

where $\omega=2\pi f$, the dipole moment is $M_0 = q_0 D$, and the charge delivered by the generator is $q(t)=q_0 sin(\omega t)=q_0 sin(2\pi ft)$. The physical constants are:

$h=6.626176\ Js$, $c = 2.9979x10^8\ m/s$ (velocity of light), $u_0 = 4\pi x10^{-7}\ N/A^2$ (permeability of free space), and $\epsilon_0 = 8.8542 \times 10^{-12}\ C^2/Nm^2$ (permittivity of free space). If the emitting electrons are calculated on the basis of all the free electrons in the antenna wire, then N_e in (4.1) is given as:

$$(4.3)\ N_e = (volume\ of\ wire) \times (free\ electron\ density) = 2\pi rD\rho$$

In (4.3) ρ is the free electron density and r is the radius of the wire. If it is further assumed the wire is, say, copper, and that there is one free electron per atom (since copper has only one 4s electron), then ρ is calculated as follows (see,e.g, Tipler[11]):

$$(4.4)\ \rho=(8.93\ g/cm^3)(6.02x10^{23}\ atoms/mol)\ (1\ e/atom)/\ 63.5\ g/mol$$

Thus, $\rho = 8.47x10^{28}\ e/m^3$. If the parameters are $f=100\ Hz$, $q0 =.1\ C$, $D=1\ m$, and $r=.001\ m$, then (4.1) yields $N=0.0983$ photons per cycle per free electron. Accordingly, on the average each free electron is emitting less than one photon per cycle, so that Einstein's theory makes no sense if it is based on the contributions of each individual electron.

5. Example Study #2 in Support of the Hypothesis

For the second example assume instead that N_e is calculated as the maximum number of electrons in a current. Then:

$$(5.1)\ N_e = q_0 / e$$

In (5.1) e is the charge of an electron ($e=1.602x10^{-19}C$). In this case N_e is considerably less than in (4.3). Nevertheless, it is still possible to cook up a set of parameters to yield $N<1$. For example, set $f=1$, $q_0=.1$, and $D=.10$. This yields $N=0.0419$ photons per emitting electron per cycle, so that the same problem is encountered which occurred in example #1.

6. Example Study #3 in Support of the Hypothesis

For the third example, it is interesting to calculate the total number of photons emitted per cycle along the entire antenna when the maximum current consists of only N_e electrons. If $f=10\ Hz$, $D=0.1\ m$, and $N_e=10^{17}$ electrons, then the dipole moment is $M_0=10^{16}$. The total number, N_{total}, of photons emitted per cycle is given as follows:

$$(6.1)\ N_{total} = WT/(hf)$$

Plugging into (6.1) the values for W, T, h and f yields $N_{total} = 0.6713$ photons emitted per cycle for the entire antenna. Thus, this dipole should never radiate, in violation of Maxwell's laws and Einstein's theory. Note that the same answer would be obtained if, instead of a dipole antenna with a current generator, the experiment were conducted by oscillating two hollow conducting spheres with N_e electrons on the one and N_e protons on the other.

7. Further Complications with Einstein's Theory

Notwithstanding the above three examples and

the previously stated intuitive argument, another daunting problem concerning Einstein's theory in the MR case involves phasing. If it is assumed that the photon emissions in the MR situation occur somewhat randomly, then it is unlikely the aggregate total of these photons will somehow result in a single electromagnetic wave of frequency f.

Also, it is pointed out that the antenna in the above three examples contains many free electrons which are bouncing around with an overall small drift velocity dictated by the applied field. These electrons are everywhere accelerating back and forth, so they would all be individually and continuously radiating streams of photons if Einstein is correct. But somehow these randomly generated photons must be all in phase with one another. This is not a problem with Maxwell's theory because of vector field cancellations.

8. Suggested Experiment to Confirm Hypothesis H

It might be difficult to confirm hypothesis H by conducting photoelectric or scattering experiments using MR because of the needed high frequencies. However, it might be possible to conduct a Young's 2-slit experiment with a low frequency MR power source. Then, according to H, the result should only show diffraction effects and no quantum effects. Thus, there should only be a gradual accumulation of a diffraction pattern on the screen and no "dots".

9. Recent Revelations Concerning Quantum Theory

While the arguments offered in the prior sections are based on what is largely classical physics theory, three recent works by this author (Aucamp[1,2,3]) explain how atoms are structured, photons are created, and what photons really are like. In Aucamp[1] it is shown that the electrons in atoms are paired into strings which exert a constant field when in orbit and therefore do not radiate. Then, in a manner similar to Bohr[4], it is shown in Aucamp[2,3] that photons are the result of orbiting electrons moving to lower energy orbits. These photon emissions are seen to be single electric field corpuscles, so that they have wavelengths of $\lambda=cT$ but no frequencies. Also, they generally have, but not always, energies given by $ET=h$. Since the photon corpuscles are single wave fields, experiments can be conducted on them which act on the fields in such a way that the photons seem to be pure waves. As these corpuscles are clearly not Maxwell's electromagnetic waves, it is seen that photons and electromagnetic waves are two different objects. Thus, the wave-particle paradox is resolved.

10. Conclusion

Arguments are offered which conclude that Maxwell's electromagnetic radiation, which is the result of accelerating free charges, do not contain photons, which are the result of atomic emissions.

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