Steady State Theory of Electromagnetic Radiation and Motion

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Abstract

The cause of electromagnetic radiation is generally believed to be due to an accelerating charge. However, physicists have also been aware of the inadequacy of this theory and have long been troubled to explain the different phenomena of electromagnetic radiation. This is not to say that accelerating charges never radiate, but to point out that the accelerating charge view does not always hold. Other attempts at alternative explanations have been made by physicists. For example, one idea is that it is the rate of change of acceleration, not acceleration, that causes radiation and radiation reaction. All existing mainstream and alternative theories have failed to reveal the principle behind all radiation phenomenon. What is the basic law of nature that underlies all radiation phenomenon ? This paper reveals a profound law of electromagnetic radiation, which we may call Steady State theory of electromagnetic radiation and motion. The proposed principle underlying all radiation phenomenon is that electromagnetic radiation occurs during the *transient* period of motion of a charge and ceases when the moving charge reaches *steady state* condition. The assumption that an accelerated charge always radiates is wrong. The Steady State theory also explains the apparently unrelated phenomenon of stability of planetary orbits. The planetary orbits are so stable because they have reached steady state condition after millions of years of transient, unstable, oscillatory motions. This paper reveals the subtle difference between inertial motion and steady state motion, and proposes to replace the former with the latter.

Introduction

The problem of electromagnetic radiation and radiation reaction has always confused physicists, including Richard Feynman who once said "we have inherited a prejudice that an accelerating charge should radiate".

It is generally believed that an accelerating electron radiates, but this theory, for example, conflicts with the phenomenon of stable atomic orbitals, i.e. why electrons in atomic orbitals do not radiate.

There is also a well known problem regarding radiation reaction. Maxwell's equations and their solutions imply that radiation reaction depends on rate of change of acceleration, and not on acceleration. This means that there is no radiation reaction during constant acceleration, implying radiation without radiation reaction.

Various proposals have been made by different authors in an attempt to solve these enigmas. One hypothesis is that it is change in acceleration, and not acceleration, of a charge that causes radiation and radiation reaction. Another proposal is that there will be no radiation if the accelerating force is perpendicular to the velocity of the charge. In other words this means that it is change in magnitude, not direction, of velocity of charge that results in radiation. However, such theories can explain some radiation phenomenon while failing on others. No theory of electromagnetic radiation exists so far that can explain *all* radiation phenomenon.

This paper reveals a profound nature of electromagnetic radiation. An insight into the problem of radiation is presented that may also help in correcting Maxwell's equations, their solutions and interpretations.

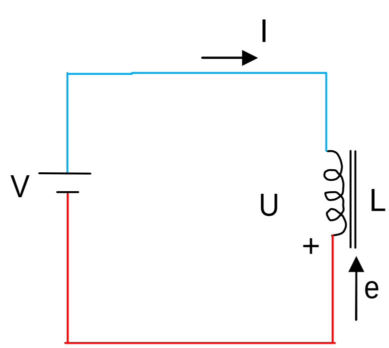
The problem of electromagnetic radiation

If acceleration of a charge causes radiation, why does an electron orbiting the nucleus not radiate? But it is accelerating!

The conventional and mainstream explanation is that an electron in an atom radiates only when its energy level changes and that it does not radiate while it is in a stable orbit. Others have proposed that an electron will not radiate if its velocity is perpendicular to the accelerating force. In such a case, the force will only change the direction of the velocity, not its magnitude. From this one might speculate that it is the change in the magnitude, and not the change in direction, of the velocity of the electron that causes radiation.

Another hypothesis exists that it is the rate of change of acceleration, and not acceleration itself, that causes radiation reaction. This conflicts with the theory that an accelerating charge radiates, because radiation and radiation reaction should exist simultaneously.

One of the problems that long troubled me regards the inductor. We know from experience that there is no induced voltage across the inductor and no electromagnetic radiation from an inductor in steady state condition.



But the electron moving in the inductor coil, even in the steady state condition, is accelerating even though its average speed is constant, because it is moving in helical (or circular) path. Why does an electron moving in the inductor coil not radiate in the steady state condition?

One idea to solve this problem is that it is acceleration of the electrons, which occurs during transients that causes electromagnetic radiation. The conventional analysis is by applying the principle of superposition in which the magnetic field strength at a given point is determined by adding the contributions of all infinitesimal current elements. With this analysis, the resulting magnetic field is static and static magnetic field will not cause electromagnetic radiation. There is a tacit assumption of a common medium (ether) in this conventional analysis. This result is also in contradiction with the theory that accelerating charges radiate.

Another problem with the changing acceleration hypothesis is that an electron orbiting a nucleus is also under constantly changing acceleration (direction), but does not radiate. This hypothesis also conflicts with the compelling theory I already proposed in [1] that inertial mass of objects is due to electromagnetic radiation reaction. If inertia is radiation reaction and if radiation occurs only during change of acceleration, then this would imply that a massive object could be moved with constant acceleration with no effort, as far as the acceleration is constant, which is ridiculous.

Yet another problem regards elliptic orbits of planets, when considered according to the theory that inertial mass is radiation reaction[1]. A planet orbiting the Sun in an elliptic orbit, unlike circular orbit, is subjected to continuously changing accelerations, both in direction and magnitude, but the planet is not radiating because we know that elliptic orbits are also stable. This indicates the changing acceleration hypothesis is not correct.

The phenomenon of Bremsstrahlung or braking radiation can be explained by the theory that an accelerating charge radiates.

Consider also a thought experiment in which an object (an electron) is moving inertially with a constant velocity V. Then the electron enters a circular orbit tangentially and revolves around a center with constant tangential velocity V and leaves the orbit after making half revolution. So the electron will be moving in the opposite direction with velocity V; so the electron has accelerated. Will it radiate or not ?

There is another problem that I wondered about. Consider a charged metallic ball connected to one end of an insulating rod. An experiment is set up so that the rod and ball rotate at very high angular speed about the other end of the rod. Will the charged ball radiate or not ?

No theory exists so far that can clearly explain *all* the radiation phenomenon discussed above. Therefore, from the above considerations, we are compelled to abandon all conventional thinking and conclude that there may be a profound mystery behind the process of electromagnetic radiation.

A new theory of electromagnetic radiation is proposed in the next section.

Steady State theory of electromagnetic radiation and motion

Consider the following phenomena:
- the inductor circuit in the steady state condition.
- an electron orbiting the nucleus
- stable circular and elliptical orbits of planets

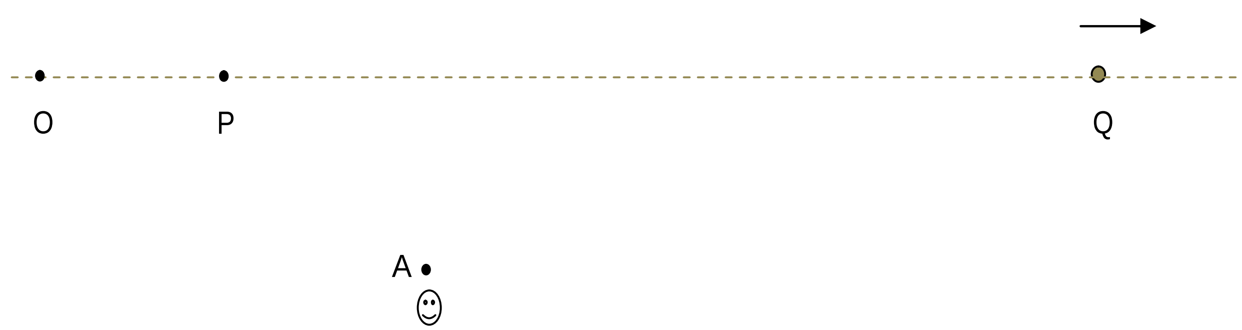
In all of these cases, there is no electromagnetic radiation.

Again consider the following phenomena:
- an electron jumping between atomic orbitals
- Bremsstrahlung or braking radiation
- an electron moving inertially with constant velocity V, then tangentially entering a circular orbit, rotating about a center with tangential velocity V, and then leaving the orbit after half revolution, going in opposite direction with velocity V

There is/will be electromagnetic radiation in these cases.

After much effort, I was able to get the insight that can explain *all* of these phenomena. We refer to this theory as Steady State theory of electromagnetic radiation and motion.

We will start with a charge Q moving with uniform velocity. In reality, the charge will initially be at rest, at point O , and then will be accelerated to a final velocity V and continue to move with this velocity indefinitely.



An observer at point A continuously measures:

- the electrostatic and magneto-static fields and
- the electromagnetic radiation from the charge.

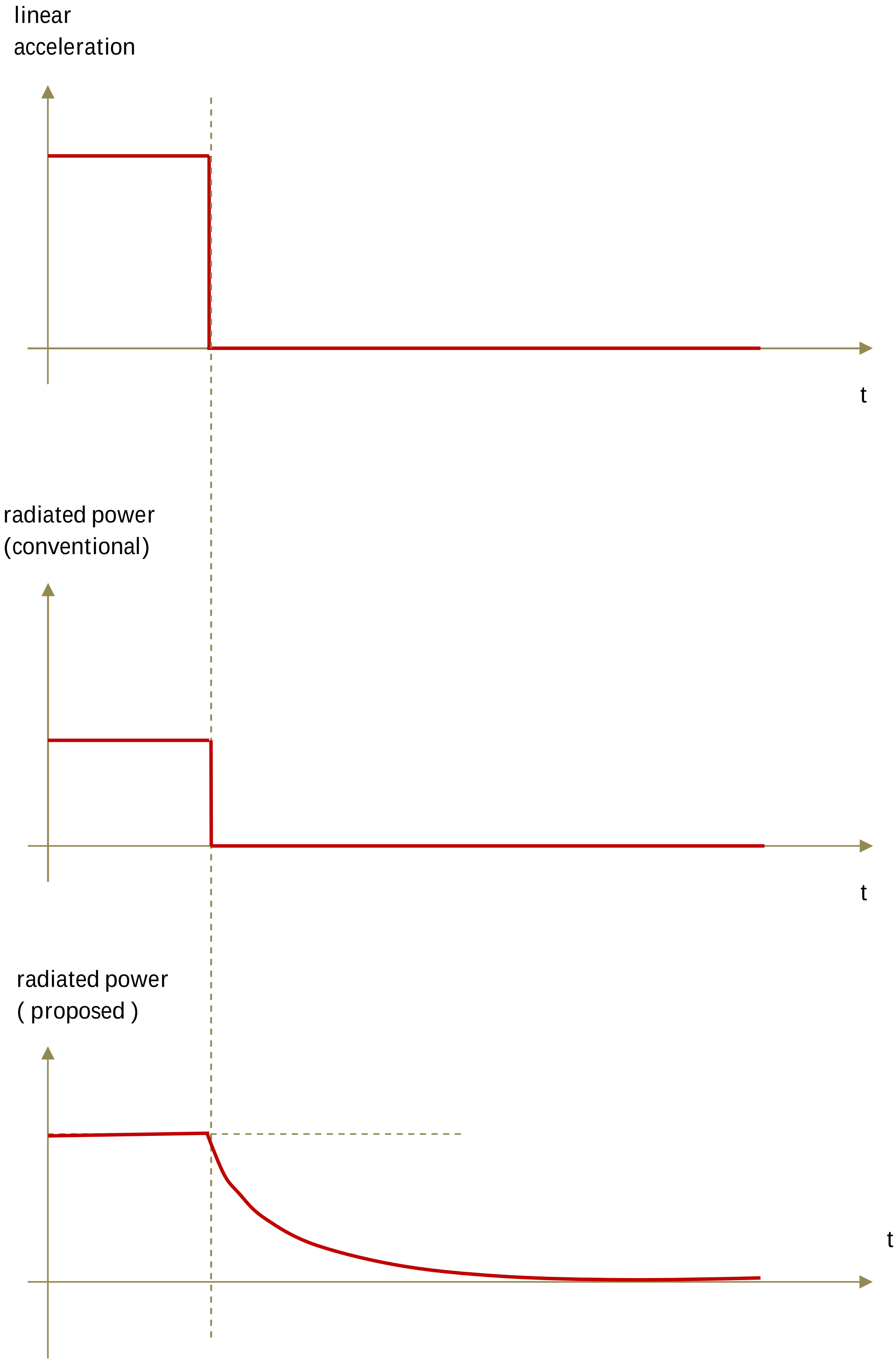
The charge is initially at rest at point O. Then the charge accelerates up to point P, at which it attains a finally velocity V and continues to move with this velocity afterwards.

The question is: what will be the electromagnetic fields and waves measured by the observer?

Obviously, up to point P, during acceleration, the observer will detect both electromagnetic radiation and changing electrostatic and magneto-static fields. The conventional thinking is that, after point P, the charge will stop radiating immediately because there is no acceleration after point P.

The new theory being proposed is that (see next figure) , in *steady state*, much after the charge has stopped accelerating, the charge will be moving with constant velocity and hence will not radiate and the observer detects only continuously changing (decreasing) static electric and magnetic fields according to Coulomb's and Biot-Savart's inverse squared distance laws, but no electromagnetic radiation. However, unlike conventional thinking, there is a delay in disappearance of radiation even after the acceleration ceases. This is a new idea being proposed in this paper. The motion of the charge is oscillatory, unsteady during the transient period and becomes steady only in steady state condition. During transient period, the magnitude and direction of the charge’s velocity is unstable and oscillating.

This is the Steady State theory of electromagnetic radiation and motion of a charge in straight line.


linear
acceleration
t
radiated power
(conventional)
t
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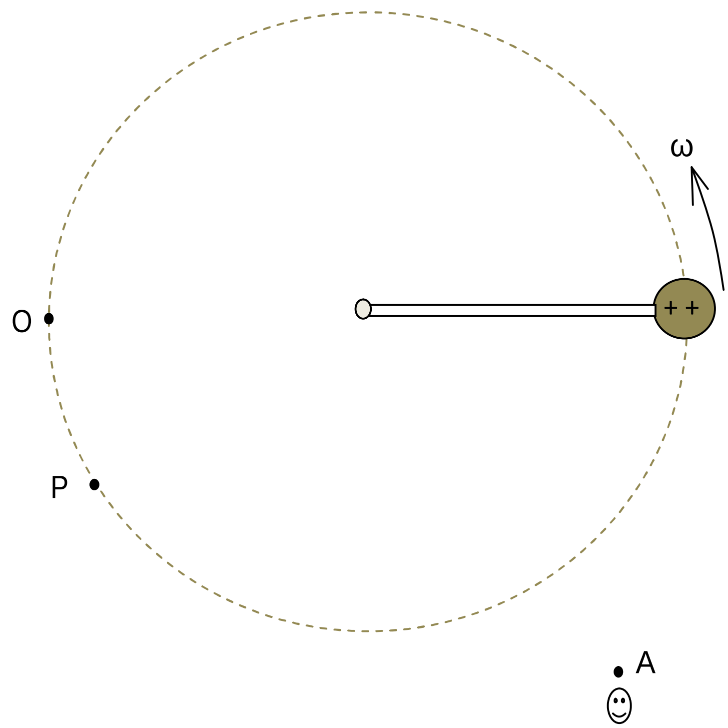
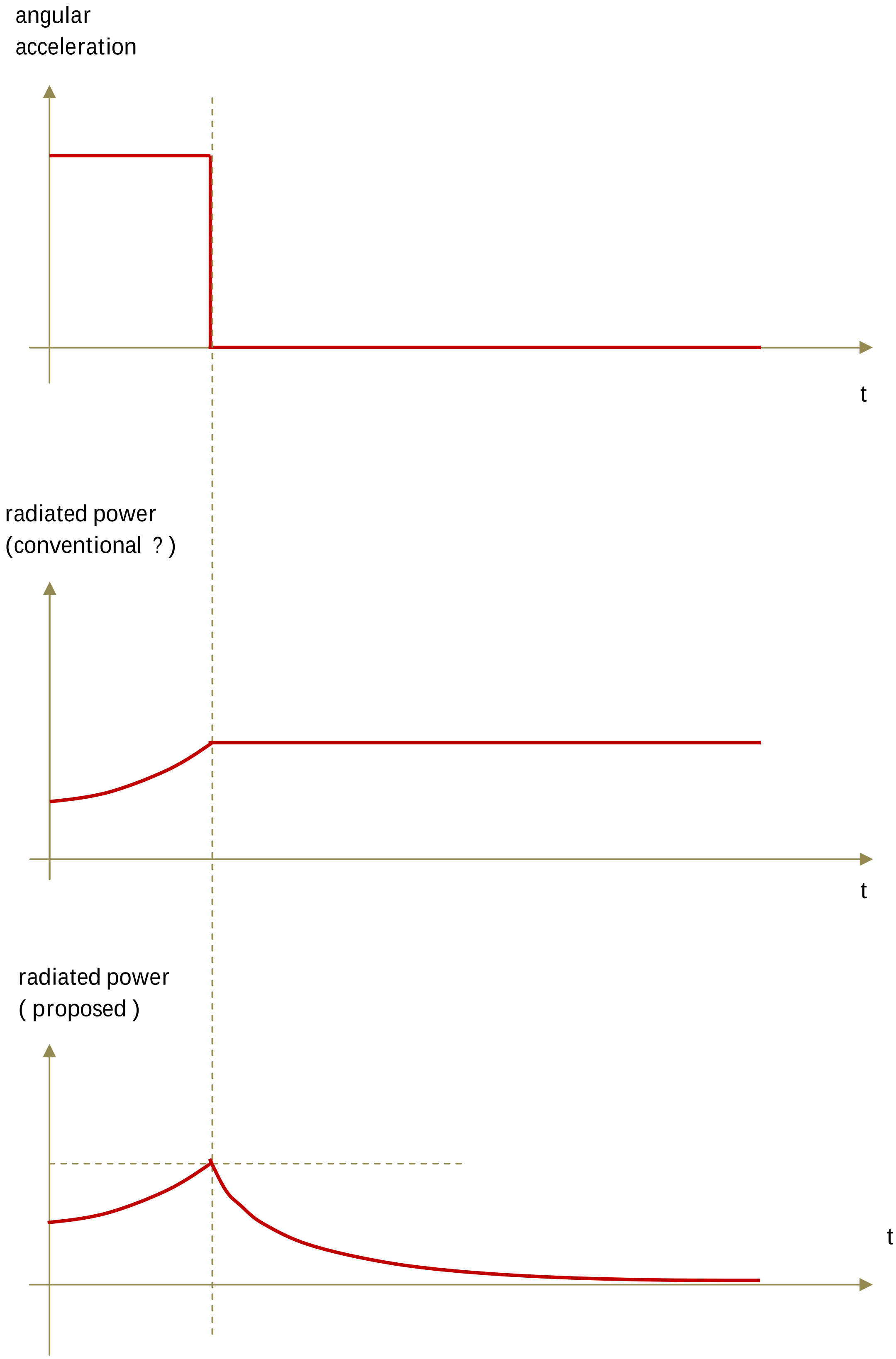
Now let us consider the case of a charge moving in an orbit around a center. Suppose that a charged metallic ball is fixed to one end of an insulating rod and that the rod and ball are rotating about the other end of the rod.



Suppose again that the ball is initially at rest at point O. Then the rod and ball start rotating about the center, with some constant angular acceleration up to point P, at which they attain a final angular velocity ω and continue rotating with the same constant angular velocity afterwards.

The new finding is that the law of electromagnetism is similar for a ball rotating about a center and for a ball moving in straight line. During the interval between the time the ball starts from point O and reaches point P, the observer detects
1. changing (pulsating) static electric and magnetic fields, according to Coulomb's law and Biot-Savart's law, respectively, and
2. electromagnetic radiation, which is due to acceleration.

At *steady state*, after the ball has made sufficiently many revolutions, there will only be the static electric and magnetic fields detected by the observer, but no electromagnetic radiation ! This is similar to the case of a charge moving in straight line. Again, like the case of the charge moving in a straight line, there will be a time lag of disappearance of electromagnetic radiation relative to ceasing of angular acceleration (see next figure). The ball's angular velocity oscillates about some value during the transient period, and becomes steady only during steady state condition.


angular
acceleration
t
radiated power
(conventional ?)
t
radiated power
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Conventionally, an accelerating charge *always* radiates. So the charged ball rotating about a center would continuously radiate because it is continuously accelerating, as shown in the figure. We have seen that this is not correct.

The initial part of the graph for radiated power is curved (and not linear) to show that two kinds of accelerations are involved: tangential acceleration and centrifugal acceleration, hence the radiated power will be greater than if only centrifugal acceleration was considered. However, the graph is only meant for qualitative description of the new theory, and may not be accurate.

In both cases of a charge moving in a straight line and revolving around a center, electromagnetic radiation occurs only during *transient* period and disappears in *steady state* condition.

This law applies not only to translational motion, but also to rotational motion. Suppose that an object is initially at rest. Then a torque is applied to it about an axis and the object rotates with some angular acceleration. The resistance to change of the angular velocity, which is the moment of inertia about the axis, is also due to electromagnetic radiation reaction.

Therefore, the traditional theory that an accelerated charge always radiates is wrong. This is not to say that an accelerated charge never radiates, but to point out that acceleration doesn't always cause radiation, as in the case of the charged ball rotating about a center, in steady state condition. This theory can easily explain why an electron revolving around the nucleus in a stable orbit doesn't radiate.

Now we can see how Steady State theory of electromagnetic radiation easily solves the problems we mentioned earlier. An electron orbiting the nucleus of an atom radiates only in transient condition and the radiation disappears in steady state, after the electron has made sufficiently many revolutions. *This means that the stable orbits of electrons in the atom are the orbits in which the electrons revolve in steady state condition*. During transient period the electron will be revolving in unstable orbits.

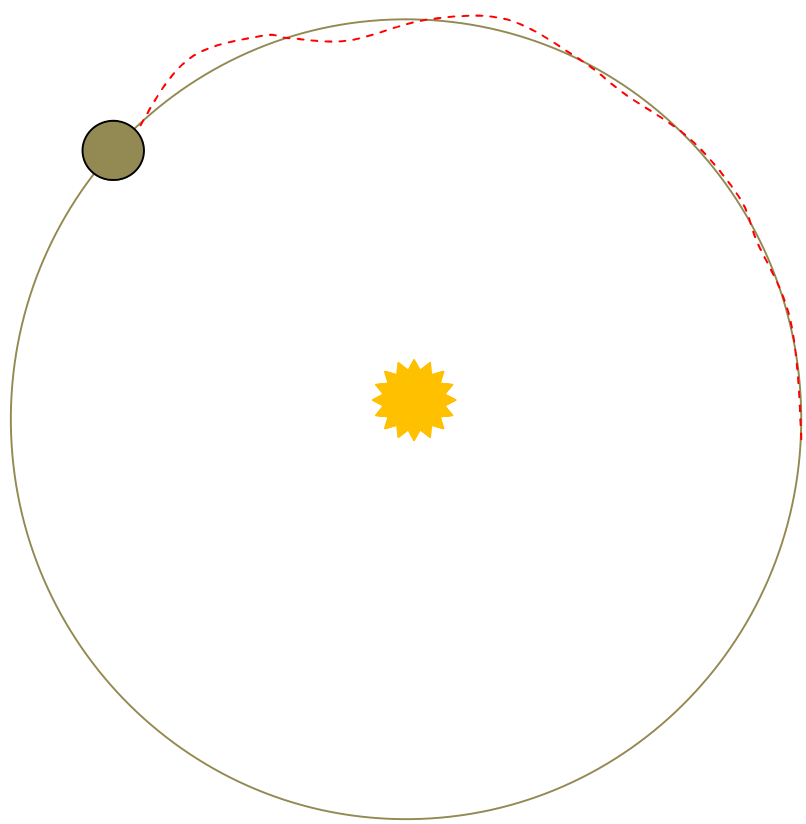
The electrons moving in an inductor in steady state condition will not radiate due to their acceleration resulting from moving in helical path in the inductor coil; the electrons are accelerating even though they are moving with constant average velocity. According to Steady State theory, the inductor radiates only during the transient period and will not radiate in steady state.

A planet in a stable elliptic orbit will not radiate electromagnetic energy in steady state condition, despite being under continuously changing acceleration. This disproves the hypotheses that radiation occurs during acceleration and during change of acceleration. The planet in a stable elliptic orbit is continuously changing its acceleration but will not radiate. A planet in a circular or elliptic orbit radiates electromagnetic energy only during transient period and does not radiate in steady state condition.

Stability of planetary orbits

The stability of planetary orbits has puzzled physicists since the time of Newton. According to Newton's laws of motion and gravitation, once a planet leaves its stable orbit, for example due to a temporary external force, the probability that it enters another stable orbit is very small. For the planet to enter another stable orbit, it should be moving with exactly the right speed, in the right direction, at the right position relative to the Sun. However, planetary orbits are known to be stable. Therefore, we conclude that it is less likely that the universe is left to Newton's laws alone.

The Steady State theory of electromagnetic radiation can explain the stability of planetary orbits. Suppose that planet Earth is initially moving in a stable orbit, when a temporary, impulsive external force slightly changes its path out of the stable orbit as shown. What happens is that, as the planet slightly leaves its stable orbit, it leaves the *steady state* condition and enters a *transient* condition. In the transient condition, the motion of the planet is unstable and oscillatory. As the momentary force slightly pushes the planet in a certain direction relative to its orbit, the planet responds by *oscillating* in its orbit. However, this *transient* condition will not last indefinitely and the planet will eventually settle in one of the stable orbits again, in the steady state condition, *after radiating away the energy of the oscillations and unstable motions*.



Note that in the above figure the oscillation has been shown to damp in less than one revolution. I propose that it would take many revolutions for the oscillations to die away.

The oscillation is explained by the theory that the radiation (and radiation reaction) will not cease immediately as the external impulsive force disappears, as already discussed.

The above theory states that a planet that leaves one stable orbit due to 'temporary' perturbations will settle in another stable orbit. However, this implies that, due to continuous perturbations from other planets, a planet's 'stable' orbit is continuously changing in a chaotic way.

I guess that the planetary orbits are stable. So how can a planet's orbit be stable in the presence of continuous perturbations from other planets ?

The stability of planetary orbits may be explained as follows, according to Steady State theory. Initially, the planetary orbits could be oscillatory and unstable, millions of years ago. They were in transient condition. However, the orbits gradually became stable in the steady state condition, over a period of millions of years, after radiating away all the energy of oscillatory and unstable motions.

A steady state condition is reached after many cycles. For example, the charged ball revolving around the center needs many revolutions to reach steady state condition. For the revolving charged sphere, one cycle is simply one revolution. The Solar System may also have reached steady state after many cycles. One cycle for the Solar System may take thousands of years and it will take many such cycles for the Solar System to reach steady state, perhaps hundreds of thousands or millions of years. Let us explain what one cycle means. Take for example the positions of each planet in the Sun's reference frame, today. After how many years do these positions repeat ? The period of one cycle is the number of years required for the solar system to repeat the same relative positions of its planets relative to the Sun. Steady State theory states that the solar system becomes stable after many such cycles. The planetary orbits eventually reach steady state after radiating away the energy of chaotic, oscillatory motions and this may take millions of years.

Note that a direct measurement of a planet's orbit may seem chaotic in the short term, but it is not in the long term. This is because the period of the cycle can be thousands of years. Therefore, the motions of planets in the Solar System is complex, yet cyclical and predictable, not chaotic. Circular and elliptic orbits are over simplification and can only be used as approximations.

This theory should also apply to the rest of the universe. The universe may have reached the present steady state condition after billions of transient, chaotic period.

Conclusion

In this paper a profound law of nature that governs the phenomenon of electromagnetic radiation and motion has been revealed. According to the Steady State theory, a charge radiates electromagnetic energy in transient condition and ceases to radiate in steady state condition. Therefore, the theory that an accelerating charge always radiates is wrong.

Thanks to God and His Mother Our Lady Saint Virgin Mary

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