EM waves resulting from the same cause never cross each other - the principle of superposition applies only to EM waves from independent sources - fundamental mistake in established methods of analysis of EM wave radiation and propagation

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Henok Tadesse, Electrical Engineer, B.Sc

Ethiopia

e-mail: *entkidmt@yahoo.com* or wchmar@gmail.com

Abstract

This paper presents a new theory of radiation and propagation of electromagnetic (EM) waves: *EM waves caused by the same cause will never cross each other*. It discloses a fundamental mistake in the established assumptions and method of analysis of radiation and propagation problems of electromagnetic waves and application of superposition principle. It implies invalidation of the established solutions to and implications of Maxwell's equations, including the invalidation of the "radiation" concept of EM waves (light). The $\frac{1}{r}$ dependent fields implied by the established methods of analysis of Maxwell's equations do not exist in reality. There is no wave "detached" from its source. The possibility of bending an EM wave on its way by another dependent EM wave will also be presented. The analogy of propagation of EM waves with the flow of fluids will also be discussed.

Introduction

According to the established assumptions and methods of analysing radiation and propagation of EM waves, EM waves from each infinitesimal element on an antenna are radiated in every direction in straight lines. The conventional method is thus application of the principle of superposition to determine the resultant wave at any point in space by adding the waves arriving at that point from all infinitesimal elements. This is the method used in solving Maxwell's equations and one of the results obtained by this method is the $\frac{1}{r}$ dependent fields, which imply "emission" or "radiation" of EM waves. This paper presents a new theory of radiation and propagation of EM.

The subsequent figures in this paper are not drawn accurately and they are only meant to illustrate the ideas.

Discussions

There is a fundamental mistake in the established method of analysis of radiation and propagation of EM waves and application of superposition principle to EM waves radiated from the *same* source and in solving Maxwell's equations. The established method is to consider each infinitesimal element on a 'radiating' antenna as carrying *independent* currents. The waves from every infinitesimal element are considered to travel in straight line from those elements to *any* point in space under consideration and superimposed on each other. The mistake stems from considering each infinitesimal element on a radiating wire (antenna) as an independent source of wave. This assumption and its consequences are fundamentally wrong. The currents in each infinitesimal element of an antenna are all caused by the same cause: the voltage source connected to the antenna; hence, all the currents in the infinitesimal elements are not independent.

Waves from same source never cross each other or superimpose. Every wave in space is traced back to an infinitesimal element (point) on the antenna. Superposition principle is not applicable because the waves never superimpose on or cross each other.

The theory presented in this paper states that waves from the infinitesimal elements of a radiating wire do not cross each other or superimpose on each other. As the waves from the infinitesimal elements are all caused by the same source (voltage source or transmitter), they cannot cross each other or superimpose on each other. This leads to EM waves travelling in essentially non straight line, especially in the vicinity of the antenna. If one traces a tiny portion of wave from any point in space back to its source (the antenna), each tiny portion of the wave will end up on a specific point on the antenna. Therefore every point on the antenna is a source for portions of wave in space. In other words, every wave in space comes from (is traced back to) a single point on the wire (antenna). The principle of superposition implies crossing of two or more waves ; so it can only be applied to EM waves originating from independent sources.

If every wave in space is traced back to an infinitesimal element on the antenna, then EM waves should propagate in non linear path because the radiating wires are not symmetrical.

It then follows that the path of real EM waves is nonlinear because real antennas or radiators are never symmetrical. Only EM waves from a perfectly symmetrical radiator will travel in straight line. This is the isotropic radiator, which never exists in reality.

The propagation of EM waves is analogous to the flow of fluids.

The infinitesimal portion of the wave from an infinitesimal element starts to propagate in a nonlinear path starting from the moment the wave leaves the element. The propagation of a wave at any point in space is determined by the instantaneous values of the causes at that point and not by the current on the antenna, once the wave leaves the antenna. The current is responsible only to the formation of the wave in its vicinity and once the wave leaves the antenna, its propagation depends only on itself and the distribution of waves in space. This is analogous to the flow of fluids. The flow of a fluid at any point is determined by the pressure gradients at that point. The fluid expands towards space with less pressure and away from spaces with more pressure. The same analogy applies to the propagation of EM waves. The EM energy at any point always expands towards the space with less energy [1]. The wave at any point in space will propagate towards the space with less power density and away from the space with more power density. This analogy applies only to waves from same cause and not to waves from different causes.

Only EM waves from independent radiating infinitesimal elements propagate in every direction and travel in straight line. The principle of superposition can apply to such waves.

Such independent radiating elements are only abstractions and do not exist in reality. One may assume a specific mathematical function for the distribution and time dependence of voltage and current along a wire. In this case each infinitesimal element is assumed to be connected to an independent source and the conventional method of analysis of the radiation and propagation of EM waves can be used. The wave from each infinitesimal element propagates in every direction crossing (superimposing on) waves from other infinitesimal elements. (Fig. 1)

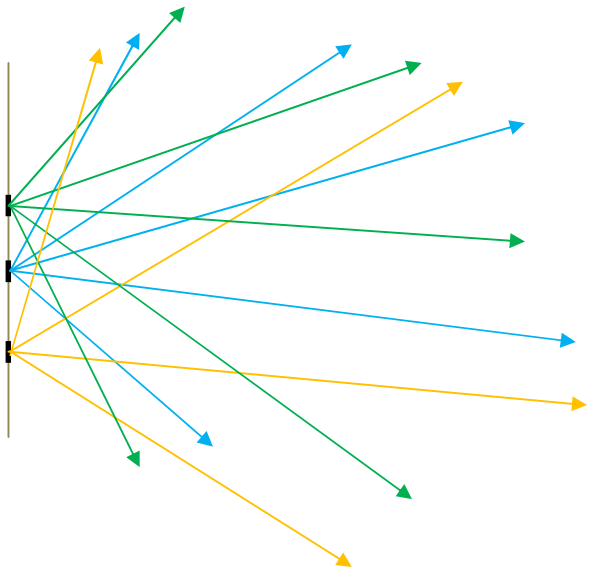

Fig.1

Radiation and propagation of real EM waves.

Consider a real wire antenna connected to a voltage source. (Fig. 2)

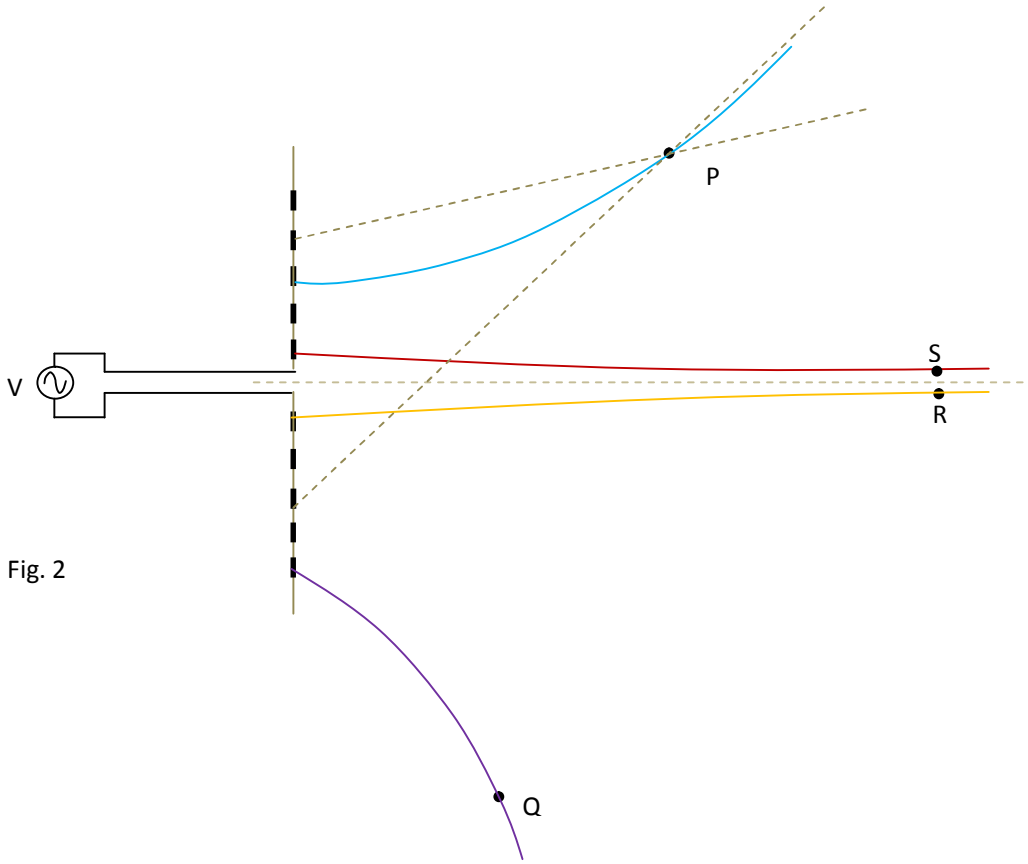

Fig. 2

In this case, the current carried by all infinitesimal elements are all caused by the same cause: voltage source V. Therefore, the waves from the infinitesimal elements will never cross each other. How is the wave at point P determined ? According to the conventional method, ***all*** infinitesimal elements will contribute to the resultant wave at point P and the resultant wave at point P is the sum of the waves from all infinitesimal elements to point P. The wave at point P is determined by superimposing the waves from all infinitesimal elements at point P, by assuming that the waves from each infinitesimal element travels in ***straight line*** to point P (only waves from two infinitesimal elements are shown in the Fig.2 by the two dashed lines). According to the theory presented in this paper, this method is wrong. The wave at point P can be traced back to a single infinitesimal element (point) on the radiating antenna, as shown in Fig.2. Similarly the waves at points Q, R and S are each shown to be traced back to single infinitesimal elements on the antenna. Therefore, EM waves at every point in space are traced back to a single infinitesimal element on the antenna. This also means that the ***waves from same source will never cross each other*** and also that EM waves will essentially travel in non straight lines, in reality. Only EM waves from a perfectly isotropic radiator will travel in straight lines [1] and obviously such radiator is only an abstraction and can never be realized.

Let us consider another case of two antennas connected to the same source (Fig.3).

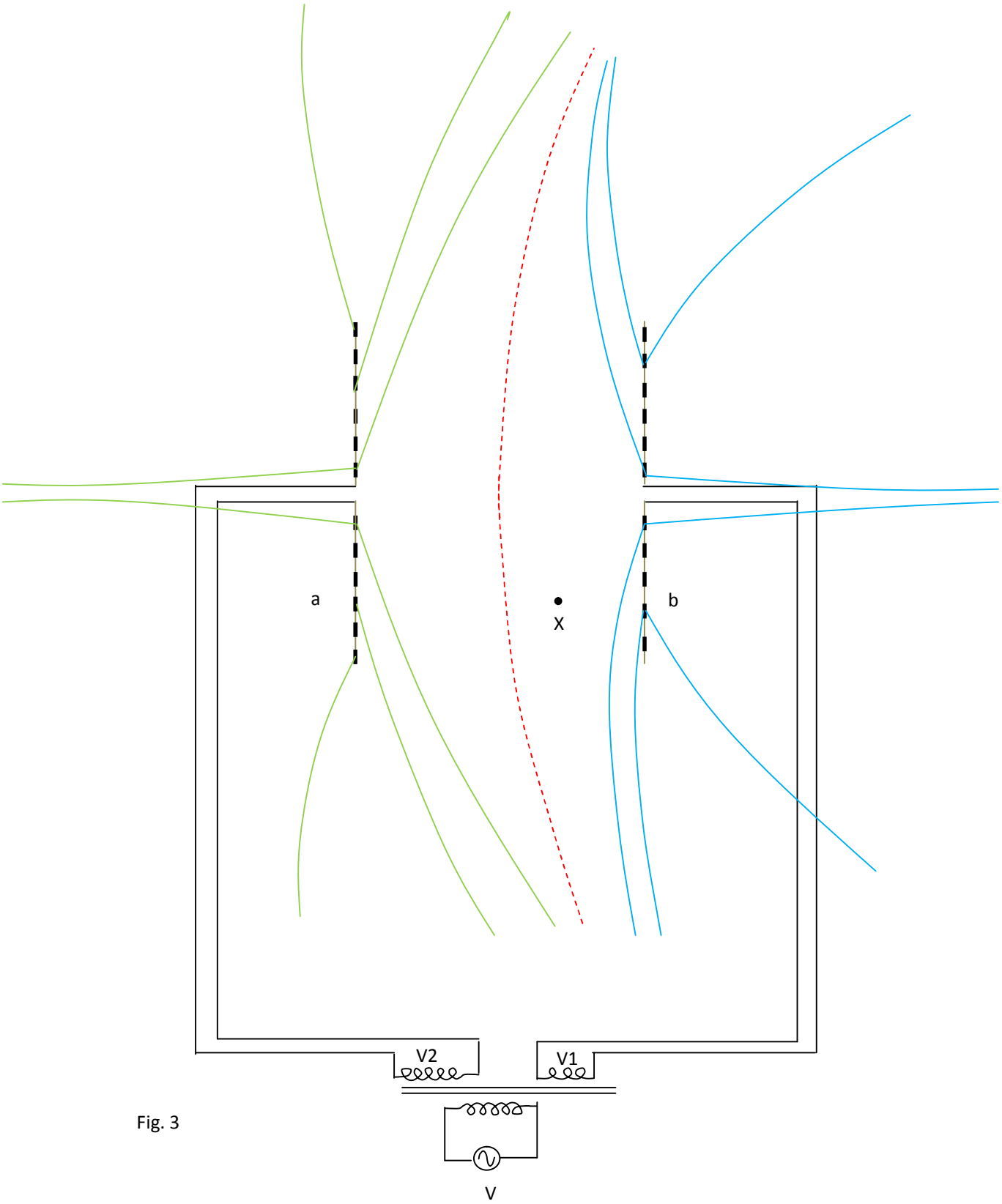

Fig. 3

As shown in figure 3, all the waves are caused by the same cause (source) : voltage source V. Therefore, all the waves that result from the source V will propagate in separate paths and will never cross (superimpose on) each other. This means that neither the waves from the two separate antennas nor the waves from the same antenna will cross each other. The wave from the antenna on the left side dominates the space because this antenna carries more current than the right antenna (the transformer secondary winding connected to the left antenna has more number of turns than the winding connected to the right antenna). The dashed red line shows the line of demarcation between the two waves. No wave will cross this line and waves from the two antennas will always be limited to one side of this line even at great distances. If the two antennas carried the same current this line would be a vertical straight line.

If no waves from antenna 'a' crosses the red line, then how does the wave from antenna 'a' affect the wave radiated from antenna 'b' ?

No wave (energy) from antenna 'a' can cross the red line (Fig. 3), but the wave from antenna 'a' will still modify the flow of waves (energy) from antenna 'b'. Even though no wave (energy) can reach point 'X' from antenna 'a', the wave (energy) from antenna 'b' to point 'X' is also determined by the wave from antenna 'a'. This is analogous to pressure waves being transmitted in a fluid without the fluid itself moving.

Now let us consider the case two antennas connected to different sources (Fig. 4).

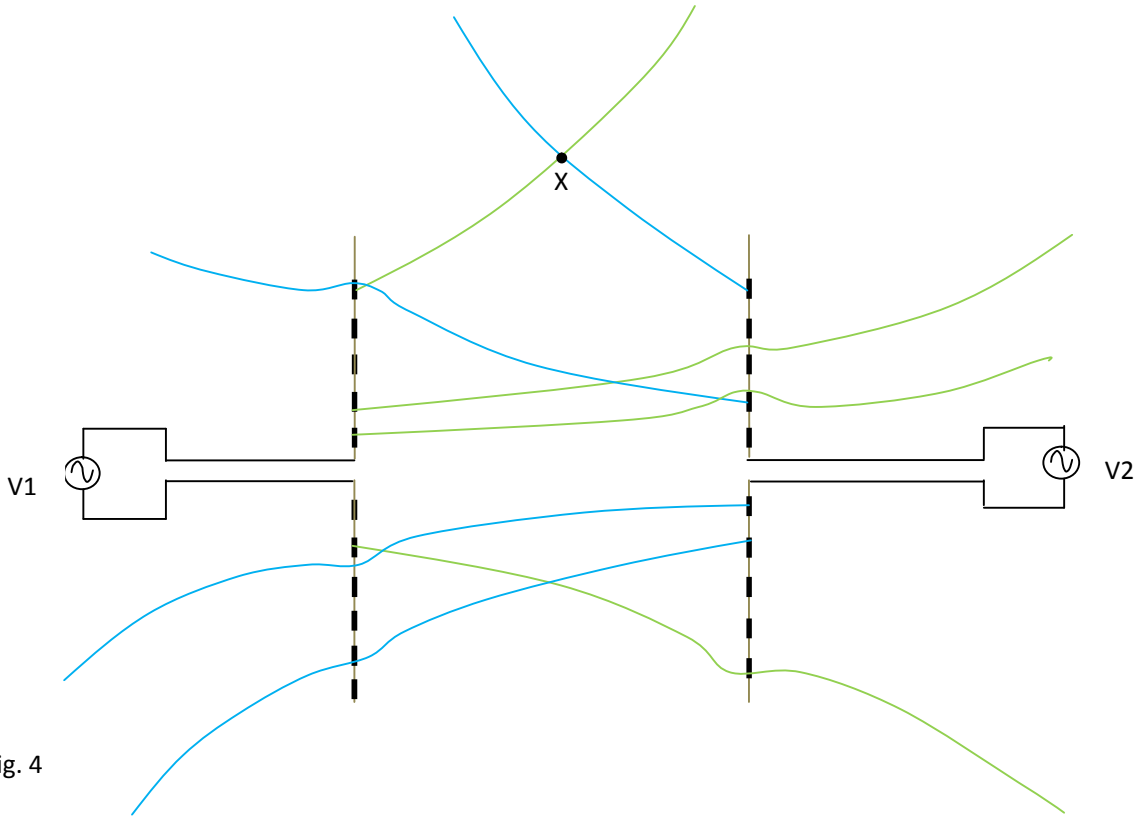

Fig. 4

In the above case, the waves from the two sources will cross each other, as shown in Fig.4 above.

Passive radiators

Let us consider a case of a (source not shown) radiating (wire ‘a’) and another nearby passive wire (wire ‘b’) , as shown in Fig. 5.

If the passive wire ‘b’ did not exist, the EM wave from active wire ‘a’ would travel to point P’, as shown by the dotted line. In the presence of the passive wire ‘b’, the wave from the active wire ‘a’ would follow the solid curved line to point P. As the wave from wire ‘a’ induces current on wire ‘b’, wire ‘b’ reradiates. This reradiated wave should not be considered as a wave from an independent source and that its effect is only modification of the direction of propagation at every point in space of the wave radiated from the active wire. This means that all waves in space are traced back to infinitesimal elements (points) on wire ‘a’ and there will be no waves that will be traced back to wire ‘b’. Wire ‘b’ will not be considered as source of any wave because it is passive. So this is a different case than the previous cases. Therefore, we may restate the law as: waves from *active* radiators caused by the same cause never cross each other. Wire ‘b’ is not an active radiator; it is a passive re-radiator.

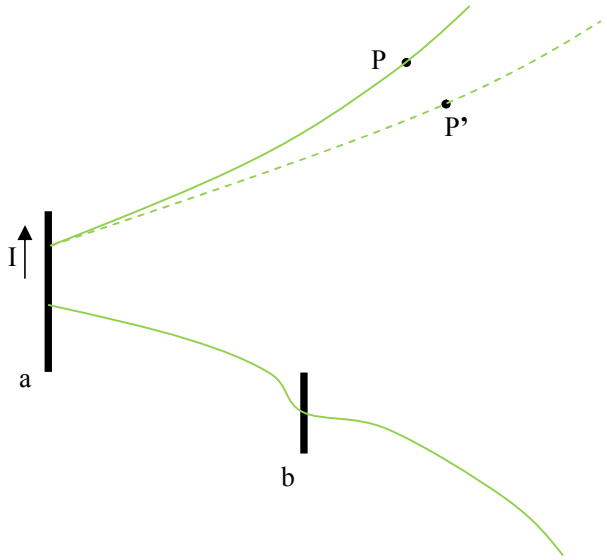

Fig. 5

What is the foundation of the theory proposed in this paper?

The theory presented in this paper resulted from close examination of the process of radiation and propagation of EM waves. However, this examination will not be presented in this paper. A simpler alternative explanation is given below.

Consider point 'X' in Fig. 3. The value of the electric field at point 'X' is a function of both V1 and V2.

$E_X = f_1(V1) + f_2(V2)$

But V1 and V2 themselves are functions of V, the ultimate cause of all the waves in this example. Therefore, Ex is ultimately a function of V.

$E_x = f(V)$

The theory presented in this paper is the interpretation of the above equation. The above equation is interpreted as : there is only one wave at point 'X' as there is a single cause : V.

Now we will consider point 'X' in Fig. 4. In this case the electric field at point 'X' is a function of V1 and V2, which are independent sources.

$Ex = f_1(V1) + f_2(V2)$

The interpretation of the above equation is that there are two waves crossing point 'X'. Each wave is traced back to its corresponding cause (V1 or V2).

Therefore, the number of waves at any point in space is equal to the number of ultimate sources.

The 'radiation' concept of EM waves is wrong. No wave is 'detached' from its source.

There is no 'radiation' of EM waves. This means that there is no EM wave that is 'detached' from its source. This means that there is no EM field with $\frac{1}{r}$ dependence on distance. The $\frac{1}{r}$ term resulted from the wrong assumption that waves from each infinitesimal element of a radiating wire travel to all points in space AND that they travel in straight lines.
The EM wave is always 'attached' to its source.

Possibility of bending an EM wave on its way by another (dependent) EM wave.

According to the law of 'radiation' and propagation proposed in this paper, it is possible to change the direction of propagation of an EM waves on its way.

Suppose the EM wave X is coming from a distant source. If this wave is received by a receiver and reradiated (without significant delay) as shown in Fig. 6, then both waves will change their direction of propagation as shown. The red dashed line is the line of demarcation between the two waves. No wave will cross this red line. The waves change direction (they don't cross each other) because they are ultimately caused by the same source: the voltage source that caused wave X. The bending angle of the waves depends on their relative strengths. If wave Y is more strong, then the wave X will bend with even greater angle.

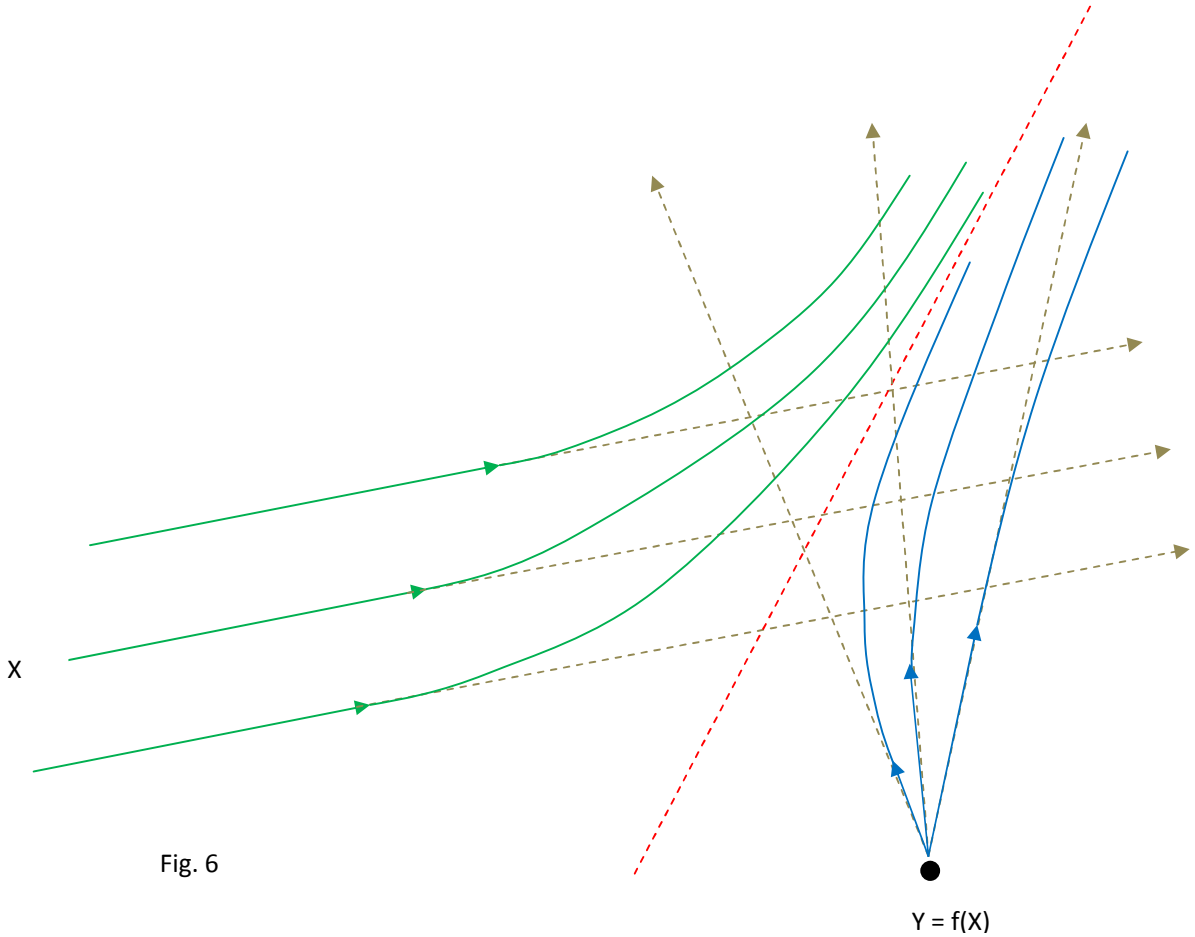

Fig. 6

Conclusion

The new theory presented in this paper is that : EM waves originating from the same source will never cross each other. This theory invalidates the methods being used so far in analysis of radiation and propagation problems. The $\frac{1}{r}$ fields which result from conventional method of analysis and which imply 'radiation' or 'detachment' of EM waves from their source and are only a result of a fundamentally wrong assumption and method of analysis.

References

1. Modified Huygens' Principle, diffraction and non-rectilinear (spiral) propagation of electromagnetic waves.

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