Refutation of Feynman's derivation of the Lienard-Wiechert potentials.

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1. Abstract.
The so-called Lienard-Wiechert potentials constitute a fundamental part of basic electromagnetic theory. Through these potentials both the electric and the magnetic fields are accordingly derived, and in following steps Maxwell's Equations may also be derived. Short-to-say, if succeeding in showing any fundamental fallacy in the derivation of the Liénard-Wiechert potentials, one could claim to have **falsified** whole Maxwell's theory, a very important prerequisite if intending to pave the way for a radically new theory. Yet, the author does not intend to create a new theory of his own. Instead, at hand is an attempt to give credit to the **far older theory** than Maxwell's, namely basically Coulomb' s Law of 1785 (or Cavendish 1771).
The author has earlier published a paper where this is done with respect to experiments performed upon Ampere's Bridge in the early 1980´s. In this paper the focus is on the way retarded potentials are derived.
The author succeeds in showing that Feynman in his derivation of the Liénard-Wiechert Potentials in the famous ***"Feynman's Lectures on Physics"*** counts the same charge twice, hence attaining a wrong expression for the electric potential, provided one is using the very idea of potentials.

2. Introduction.

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By philosophical reasons, Coulomb' s theory must again be **restored**, if finding a new way to apply it, simultaneously falsifying Maxwell's theory, due to the precedence of the first one. The author has earlier published a paper, ***Chinese Journal of Physics, VOL.35, No.2, April 1997, pp.139-49,*** **http://psroc.phys.ntu.edu.tw/cjp** where this is done with respect to experiments performed upon Ampere's Bridge in the early 1980´s. In this paper the focus is on the way retarded potentials are derived.
The author succeeds in showing that Feynman in his derivation of the Liénard-Wiechert Potentials in the famous ***"Feynman's Lectures on Physics"*** (Ref. 1) counts the same charge twice, hence attaining a wrong expression for the electric potential, provided one is using the very idea of potentials. Of course, at a given moment, a charge can only affect the field point due to one event. One of his related failures is to assume that the charge density must be assumed to be constant, as looking backwards

to the moving charge elements a 'point charge' is divided into. The author shows that this is **not** the case. The effects of retardation namely compels an 'observer' to see a **distorted charge density.**

3. Analysis of the model of Feynman.

Feynman creates the Liénard-Wiechert potential as a sum of the contributions from differential charge elements of rectangular form (Ref. 1). Relevant to the analysis is the division of the 'length' of a point charge into arbitrarily small segments of length w. He correctly assumes that every such segment would be looked at from the 'observer' at a retarded time ti = (t-ri/c), where at the field point (observer) time is assumed to be t, and finally the distance between the actual charge segment and the field point is ri.

Instead of ***adding*** the contributions from ***every charge segment*** at different retarded time events, he is adding the contribution from every Δx segment of the x axis (Ref. 1: Fig. 21-6 (a) – (e)). That makes a difference.
Due to his assumption that the time has to be regarded as constant ($t = r_i/c$) within every such segment (Ref. 1: middle of page 21-10), there inevitably appears 'time jumps' in the shape of a 'step function' at the boarder between the respective segments.
In fact, the retarded time must be a continuous function along the x axis, as the retarded time vector $\mathbf{r}_i$ changes continuously while moving along the x axis.

For simplicity, look at the first two segments of Fig. 1. As can be seen from the analysis of Feynman, at the later retarded time t_{i+1}, a little part of the charges from segment i, which has begun to arrive into segment i+1, is counted ***once more.*** Yet, a charge can of course not affect the potential at time t due to ***two different retarded time events simultaneously.***

Hence, the main fallacy of Feynman´s analysis is the discontinuous steps in retarded time. If it instead is allowed to be a continuous function, the difference in retarded time between two infinitesimally close points at the x axis approaches zero, as the distance between the segments approaches zero, and hence, so does also the charge overlap.

Feynman´s fallacy is the immediate cause behind his increase of the length of the cube from a to a + (v/c)b (Ref. 1: part of p.21-11), and accordingly the potential gets its famous denominator factor $[1 - (v/c)]_{ret}$.

If now correcting the Liénard-Wiechert potential with respect to this fallacy, it would read $q/(4\pi\varepsilon_0 r')$ – and not $q/(4\pi\varepsilon_0[1 - (v/c)]_{ret} r')$.

But the fallacies don´t end up with this. Feynman ***also*** wrongly uses the ***simultaneous charge density*** ρ in his expression for the Liénard-Wiechert potential. It appears clearly at about one third above the bottom of p. 21-10 (Ref. 1), where he says that "each volume… contains the amount of charge $wa^2\rho$, where ρ is the charge density within the cube – which we take to be uniform". This charge makes the basis for Eq. (21-31) (Ref. 1), which is wrong, since that charge density is not straightforward relevant to what happens at a distant field point. Instead, it is the ***retarded charge density,*** i.e. the charge density an observer would 'see' at the field point. Due to a

different propagation delay at different distances to the sending point, the charge density looked at by the observer ***seems*** to differ slightly from the ***simultaneous*** one at the 'sending points'. That density would read $\rho[1 - (\mathbf{v} \bullet \mathbf{r}/c)]_{ret}$ (Ref. 2).
Hence, the Liénard-Wiechert potential ought to read $q/(4\varepsilon_0 r') \cdot [1 - (v/c)]_{ret}$ instead of $q/(4\pi\varepsilon_0 r'[1 - (v/c)]_{ret})$ – the latter expression as Feynman presumes.

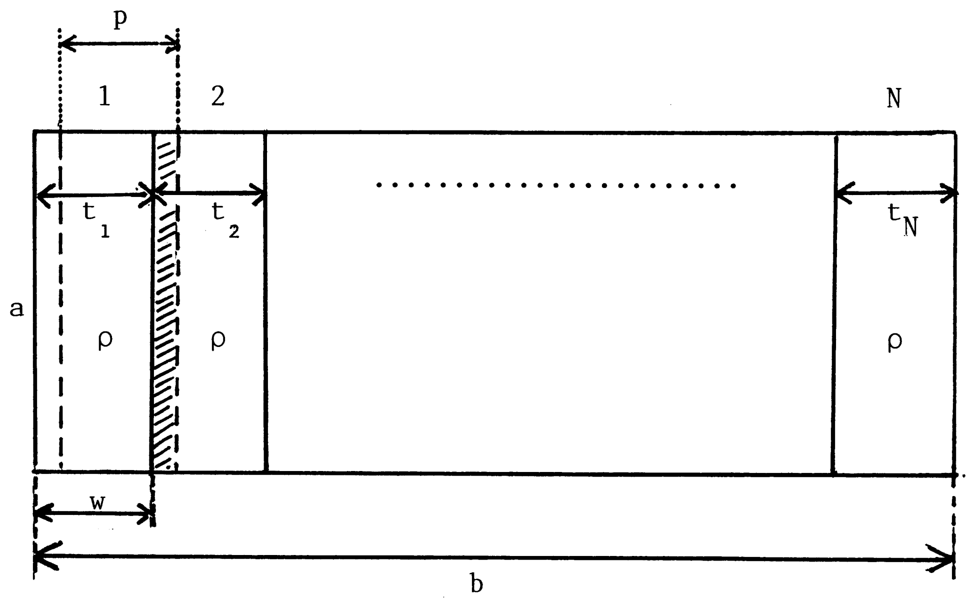

Fig. 1. A model for a travelling 'point charge' according to Feynman.

Explanations: a – the side of a cube, representing the point charge
b – The distance between the rear at time t_1 and the front at time t_N
p – The position of the 'charge slice', studied first at t_1, when the time has increased to t_2
Shadowed area – the part of the first 'charge slice' which is allowed to affect the potential at a distant field point once more at time t according to Feynman (presumably not intended by Feynman).
1,2,…N – the number of length elements into which b is divided
$t_1, t_2, \ldots, t_N$ – the retarded time denoted to every respective length element, assumed to be constant within one such length element
ρ - the charge density, assumed to be constant

4. Conclusions.

Since the Liénard-Wiechert Potentials constitute a very fundamental basis for today´s electromagnetic theory, the falsification of one of them, as has just been done above, necessarily means, that the whole modern electromagnetic theory must be abandoned, or rather reformulated.

The reason is that as well the electric as the magnetic fields are defined as linear combinations of the room and time derivates of the Liénard-Wiechert Potentials.

The author of this paper has a proposal of his own, based upon Coulomb´s Electrostatic theory, presented elsewhere [Ref. 2]. The basis is very simple, just Newton´s Mechanics, applied on charges.

5. References.

[1] Richard Phillips Feynman, (mainly Electromagnetism an Matter), Lectures on Physics, 1989, Addison-Wesley, pp. 21-9 –11.

[2] Jan Olof Jonson, Chinese Journal of Physics, VOL. 35, No. 2, April 1997, pp. 139-49, http://psroc.phys.ntu.edu.tw/cjp