ON ADVANCED POTENTIALS MEANING

1. Direct interaction and local one

In the known interpretation of the field theory (see **[Landau, Liphshitz, 1967]**) the action of a particle having a charge *e* and a mass *m* one can describe (without an external field and another charge) with expression

$$S = - m \int ds - (e/c) \int A_k dx^k$$

Here *c* is the light velocity, A_k are the field vector-potential components, and the integral should be calculated along the 4D world line from the motion *starting* point up to *final* point. The real world line corresponds with an extremum of this integral.

One may believe that the traditional description of a single charge radiation with the *retarted* potential only presents some collision with the *electrodynamics source equations reversibility*. This reversibility allows us formally to use a symmetric on time solution which presents a linear combination of the forms $f(t - x/c)$ and $f(t + x/c)$. Note that the mechanics *reversible* equations are often used to describe the object *future* evolution too. At the same time, just mechanics equations *reversibility* (as it is shown in **[Hitun, 1996]**) presents a insuperable barrier to deduce the stochastic behavior irreversibility of physical ensembles.

Meanwhile, the idea of the *symmetrc* on time elrctromagnetic interaction started to diffuse in the physicists community at the beginning of the 20th century. For example, as the authors of **[Wheeler, Feynman, 1945]** wrote, Tetrode proposed to abandon the conception of electromagnetic radiation as an elementary process and to interpret it as a con sequence of an interaction between a source and an absorber. In his words,

> "The sun would not radiate if it were alone in space and no other bodies could absorb its radiation. ... If for example I observed through my telescope yesterday evening that star which let us say is 100 light years away, then not only did I know that the light which it allowed to reach my eye was emitted 100 years ago, but also the star or individual atoms of it knew already 100 years ago tnat I, who then did not even exist, would view it yesterday evening at such and such a time. . . . One might accordingly adopt the opinion that the amount of material in the universe determines the rate of emission. Still this is not necessarily so, for two competeing absorption centers" // H. Tetrode, Zeits. f. Physik 10, 317 (1922).

As resullt, Fokker and other physicists were going to describe the action in the more symmetric on time form (see **[Vladimiroff, Turyguin, 1985]**), where the integral in the action relationship (in the Minkowski space) are calculated from some 4D pont in the past up to the symmetric 4D point in the future, not from the motion starting point up to the final point. The vector-potential ***A*** just presents a sum of such symmetric on time paired interactions for selected (radiative) particle with each from another particles of the Universe. So, the field action becomes replaced by a set of direct and non-local in the space-time particle interactions.

Such model corresponds with the Maxwell's equations, however it includes as well an "advanced" interaction as retarded one, and this contradicts to the physical intuition and the causality principle. At the second hand, thera are the important physical reasons to use just the symmetric on time presentation to describe a *microscope* interactions.

These ideas were developed in the middle of the 20th century, when the famous works **[Wheeler, Feynman, 1945, 1949]** were published, and the non-local interaction idea became the competitive one. Remember, in this local traditional model a field propagates locally **–** from one point to the neighbour ones. In this model the emission fact and source are fully independent on a futur absorbtion fact and absorber. Contrary, in the non-local model the source and an absorber become unified by this process. Note, the all symmetric on time radiation models are based on existence in the Universe a distributed *secondary charges set* that determines an important features of this phenomena.

Note that the such environment role is important in the classical electrodynamics too. In particular, this role consists in a deceleration of the wave propagation velocity relative to the velocity of light in the vacuum. The phenomena is connected with the environment bound charges that generate a secondary fields, i.e. re-emit electromagnetic oscillations having any phase delay. Really, if any *intermediate* charges were absent, then *source* oscillating charge created for *test* charge a field proportional to the factor $cos(\omega t - r/c)$, where r is a distance between the source charge and the test one. However, the source charge acts also to an intermediate charges, that implies the *additional* action (with a phase delay) to the test charge. When many such bound charges act, a so called evironment refraction index appears (see **[Feynman et al., 1963]**). If the index has a complex value, then the environment absorbs also the radiation power, not only shifts a phase.

Feynman considers the secondary charges back action to the source one and introduces two basic assumtions. The first assumption just consists in the *symmetric* using of the advanced potential together with *retarded* one. However, this assumption allows to deduce the radiative friction force value that is proportional to the secondary charge volume density and the source *acceleration* (not to the *its time derivation*, as it should be in the final result) of the emitting primary charge.

The second assumption corrects the situation. It accounts, that a large secondary charges set, that are distributed in the Universe, generates a non-zero refraction index. Because of that when one integrates over the all secondary charges set, an additional phase factor should be accounted, which depends on the volume density too. As result, after integration from zero up to infinity any dependence on the volume density disappears (but if the upper limit – the secondary charges "doud" radius – is finite, then the dependence remains!), so for each separate frequence component a factor appears that is equal to its frequence, this corresponds with the replacing a function by its time derivation.

2. Wheeler – Feynman radiation model discussion

In this Section I would like to publsh a critics on the Wheeler – Feynman radiation model. Above all, the model authors state that the correct final relationship where the retarted members remain only can be deduced from the source symmetric sum of the reatarded and advanced potentials. To my shame, I have to confess honestly that the formal proof of this fact (as well in the original papers as in another authors papers) does not seem to be clear nor unquestionable for me.

Meanwhile, the advanced potentials are attracted mainly to *explicate* so called *radiative friction with help a back action* of the secondary charge (absorbers) to the primary (emitting) one, not with help an "electron self-action" (Lorentz). The Wheeler – Feynman model attractivity just consists in that. Maybe, it is possible to unify such feedback mechanism with the traditional using of the retarted potentials only?

An Wheeler – Feynman considerations analyzis shows that they operate with the *stationary* electromagnetic oscillations *only* using a Fourrier series for separated harmonics. At any case, they use this approach in two ways from four alternative ones in order to come to final result. In this case the source electromagnetic oscillation has not the beginning nor the end on time, and each partial oscillation period (at the corresponding phase choic) cannot be *differed* from another one that precedes or followes it. Note, the same approach is to be used at the traditional consideration, because the radiative friction force calculation is based on the *stationary* (*equilibrium*) radiation power estimation, i.e. on the dependence on a frequency for a stationary process.

So, in order to base the feedback mechanism it is enough that a back *harmonic* action came to emitting charge in the *correct* phase. But such back action could be also due to a *retarded* absorber influence, if it was placed on several distance from the emitter, this (selected) distance should be divisible by *wave-length*.

But what about a back action from *another* absorbers that are not placed in these node points? I believe, their full contribution is equal to zero. In fact, consider any pair of such points, disposed *symmetrically* relative to the zero point. As a sine presents the odd function, the back radiation phases coming to the emitter are opposed, and because of that they compense one another.

With this interpretation, the Wheeler – Feynman radiative friction mechanism losts any mistery components and becomes adequate to the nature of things.

Note that the feedback existence itself should not be connected with an *advanced* action, rather contrary. So, the usual mechanical friction force F_{fr} appears as physical consequence of the external force F, and is not at all advanced. To account the friction one should replace the Newton motion law $a = F/m$ by $a = (F – F_{mp})/m$, where a is acceleration, m is the body mass. The corrected expression shows that *real* acceleration is less than *potentially possible* one because of the feedback energy loss.

The electromagnetic spatial oscillations have profound and causal likeness to the signal propagation along an electrical chain circuit or long line. Because of that the *radiative* friction accounting may be analogously performed in an electrical equivalent circuit if one replaced the current value $i = E/z$ by the the modified value $i = (E – U_{rad})/z$. Here E is the external electromotive force (due really to a mechanical oscillations of the primary emitting charge), z is impedance of vacuum (477 ohms). The member U_{rad} that is responsible to the radiative friction may be interpreted as an electrical tension at the source *internal resistance*, so it does not present an *ideal* one. The *real* current is less than *potentially possible* one because of the feedback energy loss..

The oscillations existence possibility in the pace one usually perceives as something naturally fact. Practically, it is due to an especial spatial environment having a (quantative) feature to store, to reverse a to transfere (with a finite velocity) the electromagnetic field power. The environment has a several type of sluggishness that leads the appearance of an oscillations, standing waves, and travelling direct and reflected ones.

The radiative friction interpretation as traditional (non advanced) reaction has one more profound physical reason. As it is known, this reaction is described by third order equation on the oscillating charge coordinate. At the case of a *stationary* harmonic oscillation this leads (like first order members) an *irreversible* active power loss as well in theory as in practice.

Note, at one hand Wheeler and Feynman treat *direct* particle interaction, but at another hand they account an *intermediate* environment and its refraction index. Since that index role disappears at the infinite absorbing environment radius, however this role becomes important one if this radius has a finite value.

There is one more addition. When the model authors account a power loss due to the primery emitter radiative friction, they absolutely ignore the same secondary charges (absorbers) loss. If one accounted this circumstance, he found out that an environment without power absorbtion could not exist (I believe, it is true). Moreover, the power dissipation due to back action was introduced “by hand”, out of the wave equation, because the equation was deduced from the Macswell equations for charge-free space. In principle, the charges interaction accounting should lead to replacing the traditional wave equation by the more complicate one, and its solution had to include the total secondary charge back influence description to the emitter and radiative friction phenomena.

3. Conclusion

So, does it means that direct particles interaction presents a fiction? At one hand, the light quanta moves from a star to the ground observer with the *maximal* possible velocity and because of that it may be connected with an *unique* inertial reference frame only where it is immovable; it is *impossible* to compare the reference frame clock data with this one of the Earth’s observer. In fact, at any other reference frame the light propagation requires a finite duration, but at the *proper* reference frame the quanta emission and absorbtion are simultaneous ones. So, Tetrode’s statement about a *direct* interaction between an emitter (a star) and the absorber (eyes of the ground observer) seems wonderfully to be correct.

At the other hand, when one talks about an immediate absorber *back* action to the emitter, he should consider the clock paradox solution for the light (see for original paper **[Lowry, 1963]**, or for its exposition **[Taylor, Wheeler, 1966], [Shulman, 2006]**). Firstly, when the light quanta moves *from* the emitter, one may assign to it a proper inertial reference frame. But when the light quanta reflects, this concomitant reference frame *continues* its inertial motion, and the quanta “jumps” to *another* inertial reference frame that moves now *back to* the emitter. The quanta changes the velocity and momentum sign to the opposite one, the photon frequency as decreases down to zero and then jumps up to original value; in this moment time leap appears! Namely because of that there is a pause between the radiosignal sending from Earth to Moon and the reflected signal receiving, it is exactly equal to the doubled duration of the light propagation.

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