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Researches
on
Space-Time Duality

Pierre Poubeau

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A mathematical approach of Pierre Poubeau's problem

Jean-François Geneste[i]

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Researches on Space-Time Duality

Abstract

A re-exploration of the roots of electrodynamic theories shows contradictions between physical reality and different aspects of these theories. The situations in which the actual concepts lead to incompatibilities are analysed; mainly *the field propagation* postulate is concerned. It appears that usual coupling interactions are not retarded by field propagation: they are instantaneous. This evolution involves substitution of a physical space-time with a dual characteristic to the purely mathematical MINKOWSKI Space-Time. Very simple experiments should bring proof of the validity of this approach.

Introduction

In spite of the tremendous advances in physics throughout the 20th century, a problem remains: the elimination of the anomaly presented by the contradiction between quantum inseparability and relativity. Theoretically, entangled particles seem to present instantaneous interactions at a distance; whatever mainstream physicist have evoked to assert the contrary, this, in our opinion, contradicts the logic of relativity. Here, we shall try to find a path towards a solution of this problem through a re-exploration of the foundations of physics with the help of a conducting wire proposed by Albert EINSTEIN himself, saying in 1949: "*There is not a single concept about which I am convinced that it shall remain and generally, I am not sure to have been on the right track.*(1 - Figures in brackets send to bibliography)" In 1954, he writes, in a letter to Louis de BROGLIE*: "I feel like an ostrich which hides his head in the relativistic sand to avoid to face these ugly quanta.*(2)" This scientific testament is a strong invitation to question the foundations of actual theories.

I A strange situation at the roots of relativity

Albert EINSTEIN introduces the special relativity theory in the following way.

On the electrodynamics of moving bodies (3)
by A. EINSTEIN (May 1905).

"*The Maxwell's electrodynamics - as usually understood at the present time -when applied to moving bodies, leads to asymmetries which do not appear to be inherent in the phenomena. Take, for example, the reciprocal electrodynamic action of a magnet and a conductor. The observable phenomenon here depends only on the relative motion of the conductor and the magnet whereas the customary view draws a sharp distinction between the two cases in which either the one or the other of these bodies is in motion.*"

The actual relativist electrodynamics theory considers the interaction as instantaneous when the conductor is moving in front of the magnet, and as retarded when the magnet is moving in front of the conductor. A contradiction seems to emerge within what is said in the above text.

We shall examine what the electromagnetism theory says concerning the interaction between a magnet and a conductor, according to which of these elements is in motion. We consider that the conductor forms a closed circuit of one-turn coil (figure 1).

1. Conductor in motion

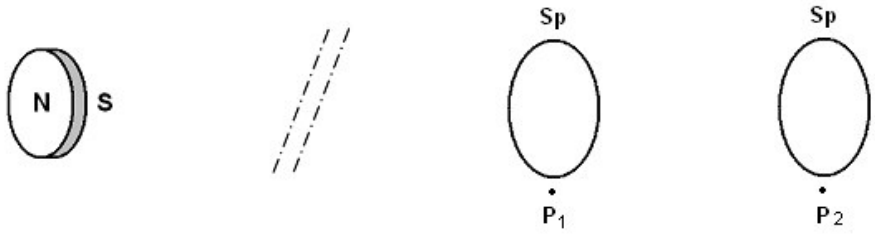

Figure 1

As soon as Sp starts from its rest position P_1 to the position P_2, it sees a variable magnetic field and an electromotive force appears in the circuit developing a current; the electrical energy has its source instantaneously in the mechanical energy applied to move the circuit.

2. Magnet in motion

The magnet is moved in the same relative displacement as previously. The relativist theory considers that if a source of field (electric, magnetic, gravitational) is modified, themodification of its field in space does not occur instantaneously but with a delay due to a propagation phenomenon at speed of light. Such is the case when the magnet NS (figure 2)

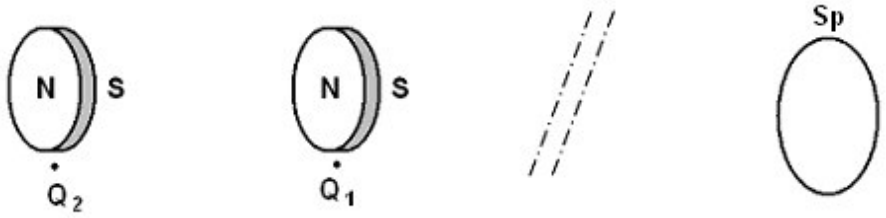

Figure 2

starts from its rest position. For example, with the magnet leaving its rest position at 30 centimeters from the circuit, the magnetic field will change at its level one nanosecond later, if it is 3 meters it will be 10 nanoseconds, and so on. It is only after such a delay that the variation of the magnetic field should occur inducing an electromotive force and a current in the circuit, this current producing a magnetic field which should propagate before reaching the magnet; *the reciprocal electrodynamic action* should take place after these two propagation delays. We can get even a step further. Indeed, physics has now a long tradition of acceptance of the action reaction principle. With the described experiments, say with magnet moving, we face the case that depending on the observation referential, such a principle would not give the same results…

Let us consider the following case; the magnet is moved from position Q_1 to position Q_2 and by the fact of the propagation delays, the return of the magnetic field of the current arrives at the magnet after it came back to a rest position. The theory foresees energy in the circuit due to the variation of the magnetic field but it is not able to propose an interpretation for the origin of such an energy transfer: *the reciprocal electrodynamic action* mentioned by Albert EINSTEIN cannot operate; it is a fundamental difference between the case where the circuit is in motion. This is just an example, among many others, of the contradictions emerging in the domain of retarded interactions, and similar problems appear with electric charges as with magnets.

The relativity proposes an other approach of the problem. Let us consider a magnet and a conductor in interaction like in figures 1 and 2 but in the outer space. Is it possible to say that one element or the other is at rest or in motion? The answer is in special relativity theory: "*the phenomena of electrodynamics as well as of mechanics possess no properties corresponding to the idea of absolute rest…it is not possible to assign a velocity vector to a point of the empty space in which electromagnetic processes take place.*(4)" So, if we are not able to say if the magnet is in motion or at rest, how could we say that it is the source of a propagation phenomenon *because it is in motion*? When a magnet is at rest in one of our laboratories, in front of a conductor, we shall say that it remains tied up to its field; but it is carried along with the earth motion on itself, with the motion of earth around the sun…. A clarification may be necessary.

II "*Retarded interactions*"

Let us consider a charge q moving in vacuum along the curve C (figure 3). According to the actual theory, the electromagnetic field in P a time t, when q is at M, is the consequence of the action of *q* passing over point M_0, at time $t_0 = t - M_0P/c$. The field is supposed to have been *emitted* and to propagate from M_0 to P at light

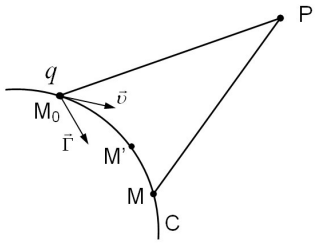

Figure 3

speed, while *q* was moving from M_0 to M. In this way, *the free field* concept is introduced: it foresees that the field is uncoupled from the charge which has *emitted* it. The field becomes *a free field,* it has no more tie with its source and it is supposed to be associated to space energy and momentum *emitted* with it at each point of the trajectory, more or less as it should be in the phenomenon of radiation. If something occurs to q between M_0 and M (for example the charge is stopped in M'), it does not matter: the field in P would have the same evolution as if q would have continued his trip up to M.

So, let us consider now the same charge q moving in the vacuum (no other charge and no current, no force applied to it) It is supposed to move along a straight line with

P
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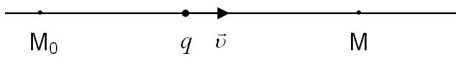


Figure 4

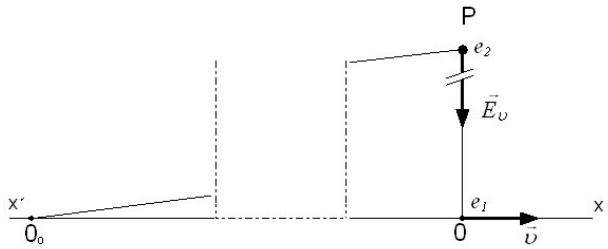
a uniform velocity. Here again, the electromagnetic field in P a time t, when *q* is at M, is the consequence of the action of *q* passing over point M_0, at time $t_0 = t - M_0P/c$. The field is supposed to have been *emitted* and have propagated from M_0 to P while *q* was moving from M_0 to M. It is supposed to be associated to space energy and momentum *emitted* and moving with it at light velocity. So we have to face this abnormal situation that a charge moving at constant speed is supposed *to emit energy and momentum*. This is incompatible with the fact that the charge is supposed to have a constant energy.

Another aspect has to be considered. When *q* is moving at speed *v,* it is because we are in a fixed (at our point of view) system of coordinates from which we see *q*

traveling at speed *v*. If the field propagation at speed *c* has a reality, this propagation appears at same speed *c* in all inertial systems of coordinates and also in the system in which *q* is static. But when we consider *q* in its own system of coordinates, it is not the source of a propagating field: we find another contradiction. The propagation of the electromagnetic field appears as the consequence of the fact that we observe the charge from a system of coordinates which is not its own one. In other words, the charge would emit its field, or not, according to the system of coordinates from witch it is observed: it is not acceptable.

These anomalies may be analyzed in a more concrete way. An electron e_1 is passing at O with the velocity *v*, coming from infinite (figure 5); its electric field at P reaches a maximum value at this instant. According to the theory, the field at P is not in relation with the presence of e_1 in O but in consequence of passing previously through O_0 and its value depends of the speed of the electron. Let us take the example of an electron the speed of witch is very closed to light speed ($v/c = 1 - 10^{-12}$). When e_1 is in O, it exerts, on another electron e_2 in P at one kilometer of O, a force which communicates it an acceleration of 20g. In the actual state of the electromagnetic theory, it does not matter if e_1 is immobilized immediately after

Figure 5



passing O_0, but this position is at 700 000 kilometers upstream from O (the retarded position is farther and farther when *v* increases)! The LIENARD -WIECHERT Potentials lead to the exact value of the field, but starting from a hypothesis which is not compatible with physical reality (retarded potentials and *q* affected of a directional coefficient).

The analysis of the interaction between a moving electric charge and a conducting circuit gives some landmarks. A simple example corresponds to the interaction between an electron *e* of beta radiation and a one turn coil, the electron being emitted in the vacuum from point M_0 at time t_0 with velocity *v* just a little smaller than *c*; the coil S is centered on point P (figure 6). The electron is stopped at N in a target C, the position of which is such that *e* arrives to N

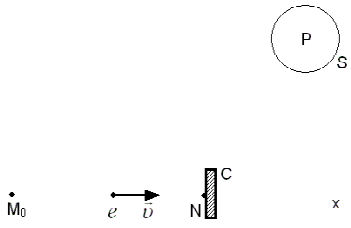


Figure 6

before the electromagnetic field, which is supposed to proceed from each point of *e* trajectory, reaches the circuit. The theory foresees that the field, after it will have reached the circuit, will induce a current into it, involving energy although there is no possibility for the electron to be at the origin of this energy, since their was no possibility of *reciprocal electrodynamic action*.

III First steps in re-exploring the roots of the electromagnetic theory

Initially, the field propagation concept was introduced through MAXWELL's Theory. Let us look then what comes out from this theory and from MAXWELL's Equations. With the actual formulations and units, these equations are:

MAXWELL's Equations Group I

$$rot\ \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad (1), \qquad div\ \vec{E} = \frac{\rho}{\varepsilon_0} \quad (2),$$

$$rot\ \vec{B} = \mu_0 \vec{j} + \varepsilon_0 \mu_0 \frac{\partial \vec{E}}{\partial t} \quad (3), \qquad div\ \vec{B} = 0 \quad (4),$$

$$\Delta \vec{E} - \boldsymbol{\varepsilon_0 \mu_0} \frac{\partial^2 \vec{E}}{\partial t^2} = \frac{1}{\boldsymbol{\varepsilon_0}} grad \boldsymbol{\rho} + \boldsymbol{\mu_0} \frac{\partial \vec{j}}{\partial t} \quad (5).$$

$$\Delta \vec{B} - \boldsymbol{\varepsilon_0 \mu_0} \frac{\partial^2 \vec{B}}{\partial t^2} = -\boldsymbol{\mu_0} rot \vec{j} \quad (6).$$

The parameters ε_0 and μ_0 characterize the fact that the sources are in vacuum (nothing else that charges and currents in the whole space). The key action of James Clerk MAXWELL was the introduction of the term $\varepsilon_0 \mu_0 \partial \vec{E}/\partial t$, which did not exist before him, in equation 3. Equations 5 and 6 are derived by mathematical identities from fundamental equations 1 to 4 and they help to understand what follows.

The reasoning which starts from here is the following.

"*In vacuum where there is no charge and no current, the electromagnetic field is described by these equations in which:* $\rho = 0$, $\vec{j} = 0$" (5,6,7,8, 9,10):

MAXWELL's Equations — Group II

$$rot\ \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad (1'), \qquad div\ \vec{E} = 0 \quad (2'),$$

$$rot\ \vec{B} = \boldsymbol{\varepsilon_0 \mu_0} \frac{\partial \vec{E}}{\partial t} \quad (3') \qquad div\ \vec{B} = 0 \quad (4'),$$

$$\Delta \vec{B} - \boldsymbol{\varepsilon_0 \mu_0} \frac{\partial^2 \vec{B}}{\partial t^2} = 0 \quad (7)$$

$$\Delta \vec{E} - \boldsymbol{\varepsilon_0 \mu_0} \frac{\partial^2 \vec{E}}{\partial t^2} = 0 \quad (8)$$

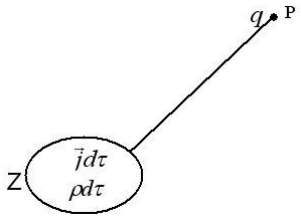
With the same mathematical identities which allow to go from equations 1 to 4, to equations 5 and 6, we go from equations 1' to 4' to equations 7 and 8.

The conclusion drawn by James Clerk MAXWELL and presented in the chapter *Electromagnetic Theory of Light* of his *Treatise of Electricity and Magnetism* (11) is

the following : "*Taking into account the analogy of equations with those concerning propagation of a deformation in an elastic body, the electomagnetic field propagates through waves*." About twenty years later, Hendrik Antoon LORENTZ in his *Theory of Electrons and its Application to the Phenomena of Light and Radiant Heat* (12), actualizing MAXWELL's Theory, considers, as a support, the analogy with the equation of a vibrating string and arrives at the same conclusion: the electromagnetic field propagates through waves (MAXWELL-LORENTZ' Theory). Up to now, these equations have systematically led to the same conclusion.

But let us come back to the field concept as it was at that time, and on which MAXWELL's Equations were developed. A zone Z is embodying charges and currents (figure 7) around which, there is nothing up to the infinite space. If another charge *q* is in P, it is submitted to a force due to charges and currents in Z. What ever these charges and currents are, the definition of the electromagnetic field allows us to know what force the charge *q* is submitted to, under the condition that we know the vector characterizing this field. If there is no charge and no current in space, there is no field and no possibility to write equations between fields

Figure 7



which do not exist. When a charge and/or a current (which is moving charges) are introduced in Z, the field is present simultaneously. If there is an evolution concerning charges and/or charges positions, there is a simultaneous evolution of the fields all over the space.

The fundamental MAXWELL's Equations (1 to 4) have been elaborated on the basis of such a field concept. MAXWELL's Theory goes from the fundamental equations (1 to 4 above) to propagation equations by passing from group 1 to group 2 involving what is the following:

Group 1: no source→no field
Group 2: no source→fields

Originally, group 2 equations appeared as a direct consequence of MAXWELL's Equations 1 to 4. This is not the case; it is the consequence from a hypothesis completely different of the initial one corresponding to the field concept. As soon as equations of group 2 are written, leading *ρ and* $\vec{j}$ to zero*,* it implies to consider that fields exist without sources, in complete contradiction with the initial hypotheses on

which equations of group 1 have been built, and before arriving to propagation equations.

In doing so, the attempt to represent physical reality is founded on a completely different basis than the one on which equations 1 to 4 have been established. We have to determine if this changing of basic hypotheses has obtained sufficient consideration. The present researches arrive at the conclusion that the track opened by the step between group 1 and group 2 was tremendously profitable but here the genius of James Clerk MAXWELL has operated in counter-flow to logic. This step has opened the way of 20th century physics and the way of many breakthroughs but it leads also to the contradictions appearing in the introduction of relativity indicated above and to the contradictions between relativity and quanta theory because the non-logical step remained unnoticed.

IV From MAXWELL's Theory up to now

After HERTZ' Experiments, MAXWELL's Theory is considered as valid and opens a new branch in physics: radio-electricity. But invariance of light speed, *ultraviolet catastrophe* and photoelectric effect appear which question MAXWELL' Theory.

In May 1905, introducing quanta as particles, Albert EINSTEIN disconnects light from MAXWELL's Theory which foresees that

"*Energy is continuously distributed on an increasing volume*"

when, in fact,

"*Light is constituted of quanta of energy emitted from one block and moving without any division.*"(13)

In June 1905, Albert EINSTEIN presents the special relativity theory which concerns MAXWELL's Theory and radio-waves; it also deeply concerns light, but without a single word about quanta as if they should not exist. In the text completing special relativity and demonstrating the mass-energy equivalence, he writes:

"*I based that investigation on the MAXWELL-HERTZ equations for empty space, together with the maxwellian expression for the electromagnetic energy of space.*"(14)

After HERTZ' Experiments, one way is opened for electromagnetism, according to MAXWELL's Theory: schematically, the electromagnetic field leaves its source at speed *c*, associated to energy and momentum.

Albert EINSTEIN opens two different ways for the interpretation of radiant electromagnetic field, one for light, one for radio-electricity:
- in the first way, the radiant energy is constituted of quanta emerging from a particle creation process; this domain concerning initially light extends from gamma rays to *black body* infrared. Albert EINSTEIN will give others contributions in the same domain (discovery of stimulated emission, BOSE-EINSTEIN Statistics….). The process of particle-antiparticle creation is discovered later, the quanta, photons since 1926, being simultaneously the particle and the antiparticle.
- in the second way, the electromagnetic field is supposed to leave directly its sources and to spread in a continuous way in space, bringing energy and momentum (later kinetic momentum also); the development of radio-electricity progresses, on this basis, step after step, in accordance with MAXWELL's Theory (in fact with MAXWELL-LORENTZ Theory). Albert EINSTEIN brings a complementary contribution with general relativity; as far as electromagnetism is implied, he refers to MAXWELL-POYNTING's Equations, remaining in the idea that radio-waves are emitted in complete disconnection from quanta.

In the development of experiments initiated by Heinrich HERTZ, radiations were observed in the domain of sub-millimeter wavelengths which is also the domain of the infrared of *black-body* radiation. Initially, this was considered as a proof of the unity of nature for light and electromagnetic waves. But when quanta are introduced in light what about radio-wave? The problem was not set forth by Albert EINSTEIN but there was a **completely implicit** answer: quanta for thermal infrared, MAXWELL-HERTZ' field for radio-electric infrared.

The dichotomy between the two modes of radiating energy was questioning the physicists. In 1909, Albert EINSTEIN says having the hope of: "*a light theory which should be interpreted as a sort of fusion between the wave theory and the particle emission theory.(15)*" This preoccupation is mentioned also by Louis de BROGLIE in 1924, in the thesis which introduces wave mechanics: « *It should be necessary to constitute a new electromagnetic theory taking into account the discontinuous structure of radiant energy, letting to MAXWELL's Theory a character of statistical approximation which would explain the legitimacy of working with it and the exactitude of its predictions in a very large number of cases*.(16)"

A synthesis in this direction is acquired since the middle of years 1920. A new way is opened (Pascual JORDAN, Paul DIRAC, Werner HEISENBERG, Max BORN and other physicists) with the mathematical quantification of the electromagnetic field (quantum field theory, quantum electrodynamics). It is another access to the microscopic phenomena of physics after wave mechanics and quantum mechanics, all of them being at the origin of tremendous breakthroughs. In spite of all these advances, the anomaly of quantum inseparability remains without solution.

The mathematical quantification of the electromagnetic field has its basis on MAXWELL-LORENTZ's Theory. So, all what is done mathematically remains on this foundation: *the field propagates from its sources, taking with him the energy and momentum distributed in a continuous form through space*. The introduction, in the mathematical process of *particle creation operators,* opens the way of an extremely profitable representation of the situation but does not express completely the physical reality. The mathematical formalism, has the capacity of **letting appear** under a discontinuous form an energy supposed continuous at the emission, it has not the capacity of **transforming** an energy which should be **physically continuous** at the departure, into an energy which should be **physically discontinuous** at the arrival. But it can bring decisive elements leading to recognize that the starting hypothesis was not expressing completely the physical reality. An enormous part of the acquired knowledge would remain but something important should have to be changed. In the same way leading to introduce instantaneity in the interaction between a magnet moving in relation with a conductor, we have to introduce the instantaneity in the interaction between two electric charges. For example the interaction between an electron and a proton or between two protons, or two electrons, is an instantaneous interaction, whatever is the distance between the particles; this means that potential energy is converted instantaneously in kinetic energy. When two elementary particles are in interaction, the interpretation through the concept of virtual photons has perhaps to be reconsidered; the problem appears more clearly at a very large distances, if we try to utilize *the virtual photon concept*.

For a wide part, a clarification of the situation has resulted from the theory and operation of maser, and from the continuity of principle between maser and laser. Maser operates in radio-frequencies domain and the radiated energy has the same quantum structure as light. The consequences of this situation did not appeared immediately, but they are decisive: **maser effect plays the same role as photoelectric effect has played, half a century sooner;** it brings the proof that the radio-wave energy is constituted of *quanta emitted in one block*. There is another proof: when a radio-wave emission is detected at low level of power, the quantum discontinuity appears. Consequently, it cannot be interpreted through MAXWELL's Theory which foresees "*an energy continuously distributed on an increasing volume*"; the reason which led Albert EINSTEIN to disconnect light from MAXWELL' Theory is transposable to radio-wave. It remains no more experimental proof of the **direct** propagation process for the electromagnetic field.

When we go from group 1 equations to group 2 equations, it is not a right track as far as logic is implied, but a tremendously useful track coming from MAXWELL's **genius**. Propagation equations are not in the straight line of fundamental MAXWELL's Equations. They are the consequences of the divergent hypothesis, as far as logic is involved, which supports the fact consisting to take to zero ρ and $\vec{j}$. The electromagnetic field has no possibility of leaving its sources except through the process of particle creation and this implies that charges are submitted to a sufficient acceleration level. So, a magnet moving in usual condition is not the source of a propagating field and it is not the source of *retarded interactions*. Here, we are

coming back to the interaction between a magnet and a conductor to consider that the interaction is instantaneous whatever is the moving element.

If we have some reasons to consider that the theory leading from fundamental MAXWELL's Equations to propagation equations is not a logic track, we have also to balance this criticism. If we feed an antenna with the electromagnetic energy coming from a stimulated emission system, we know that the energy is constituted of quanta. But we need also to know the radiation diagram and the corresponding data are provided by the theory of antennas: it is directly derived from MAXWELL-LORENTZ's Theory. This explains, for a part,
why MAXWELL's Theory was so successful, in spite of quanta, in radio-electricity and in mathematical quantification of electromagnetic field. Introducing quanta Albert EINSTEIN says, considering the case where a great number of quanta is involved: "*The wave theory of light is perfect and it may be that it will never be replaced by any other one.*(17)" For the same reason, we can understand that the theory is so successful supporting the quantum electrodynamics in spite of its divergence towards physical reality on one of its arms.

Although these researches are oriented towards electromagnetic physics, it is not disconnected from gravitation. The concept of retarded interactions has its source in electromagnetic field and it has been extended to gravitational field. The idea was developed that the gravitational field is able to leave its sources directly, in the same way as the electromagnetic field does (The Foundations of the General Theory of Relativity by Albert EINSTEIN, 1916). The situation is similar, but in the electromagnetic field we have the experimental proof that when propagation phenomena occur, it is through the particle creation process, and not through the process of field coming off. There is nothing equivalent in the domain of gravitational field. This situation can help to understand why it is impossible to quantify the gravitational field.

In the two domains, these researches lead to a very different physics compared to what we are accustomed to, as far as its foundations are concerned. Starting from the magnet conductor experiment, a wide experimental program shall be necessary to discover the new sources-fields laws. As mentioned above, we have seen that quanta do not exclude the absolute necessity of coupling them with MAXWELL's Theory. Similarly, it seems that a certain form of propagation delay should have to be introduced but in a completely different process than retarded interactions with energy and momentum propagation without photons. These aspects are out of the scope of these researches: the objective is to perform the experiment already in filigree in the introduction of special relativity and to verify that the magnet-conductor interaction is instantaneous, whatever is the moving element; then, the whole situation will be clarified to go forward.

V Space-Time Duality

The conclusions of these researches will not come before a decisive experiment, the typical one being the analysis of the interaction between a moving magnet and a conducting circuit in front of it. Assuming a positive result of this experiment, it implies that relativity is compatible with instantaneous interactions and it implies its actualization. It will also open the way to a new space-time with a dual characteristic. In one of its facets this new space-time, **of physical nature**, corresponds to what is foreseen by relativity in its actual state concerning interactions by photons; in the other facet, it provides the compatibility with instantaneity of coupling interactions which leads to find again simultaneity in different systems of coordinates **without questioning the impossibility of detecting an absolute motion**.

In any case it will be interesting to observe that the concept of stimulated emission was discovered by Albert EINSTEIN in 1917 and the first maser emission was realized in 1954, operating in the radio-wave domain. It plays the same role to impose the photons in radio-wave than the photoelectric effect in light on 1905. It is in the same year where Albert EINSTEIN writes, in a letter to Louis de BROGLIE, that he has privileged relativity to quanta. It is true that the right track would have been to extend directly the quanta to the radio-electric domain. The consequence would have been to renounce to field propagation and to arrive at instantaneity in coupling interaction. Then it was no more possible to question simultaneity, there was no more reason *to synchronize the clocks* by light signals and it was no more possible to develop special relativity. Genius has operated at counter-flow of logic; nevertheless the iterative track was tremendously successful.

I am indebted to the persons who helped me in this work and who made this presentation possible.

■ ■ ■ ■ ■ ■ ■ ■ ■ ■

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A mathematical approach of Pierre Poubeau's problem

France Russia colloquium

Jean-François Geneste[ii]

Introduction

In this short paper, we revisit Pierre Poubeau's approach, on a mathematical point of view and try to generalize it.

1. MAXWELL EQUATIONS

Let us recall Maxwell equations in vacuum.

$$rot\ \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad (1), \qquad div\ \vec{E} = \frac{\rho}{\varepsilon_0} \quad (2),$$

$$rot\ \vec{B} = \mu_0 \vec{j} + \varepsilon_0 \mu_0 \frac{\partial \vec{E}}{\partial t} \quad (3), \qquad div\ \vec{B} = 0 \quad (4),$$

$$\Delta \vec{E} - \boldsymbol{\varepsilon_0 \mu_0} \frac{\partial^2 \vec{E}}{\partial t^2} = \frac{1}{\boldsymbol{\varepsilon_0}} grad \boldsymbol{\rho} + \boldsymbol{\mu_0} \frac{\partial \vec{j}}{\partial t} \quad (5).$$

As explained by Pierre Poubeau, these equations are the ones of Maxwell in ***vacuum***. Now, it is traditional to extend these equations by continuity by writing:

$$rot\ \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad (1'), \qquad div\ \vec{E} = 0 \quad (2'),$$

$$rot\ \vec{B} = \boldsymbol{\varepsilon_0 \mu_0} \frac{\partial \vec{E}}{\partial t} \quad (3') \qquad div\ \vec{B} = 0 \quad (4'),$$

$$\Delta \vec{B} - \boldsymbol{\varepsilon_0 \mu_0} \frac{\partial^2 \vec{B}}{\partial t^2} = 0 \quad (7)$$

$$\Delta \vec{E} - \boldsymbol{\varepsilon_0 \mu_0} \frac{\partial^2 \vec{E}}{\partial t^2} = 0 \quad (8)$$

In the absence of charges and currents.

Now, the question is to know whether such a way of doing is legitimate. First of all, we must recognize that such a way of doing is overwhelmingly spread in the world of physicists.

However, do we really have, formally, the right to extend those equations by continuity? Quantum physics tells us that there is a quantum of charge under which it is not possible to go, that is, the charge of the electron. Of course, we shall be opposed that some quarks have lower charges, but, in no case there is any clue that there could be a continuity of the charge decreasing down to zero. Therefore, in equation (2) for example, in the neighbourhood of zero, the charge is no more derivable neither continuous. We therefore would only have a countable set of physical equations on one side for different values of ρ, whereas we would have a formal (i.e. mathematical) non countable set of potential solutions corresponding to a continuous variation of ρ. Moreover, formally, equation (5) includes the expression $grad\,\rho$. But in zero, such an expression does not exist due to the quantum existence of the charge. So that extending equation (5) by continuity and derivability to equation (8) looks a bit like a deviation to orthodoxy.

2. THE FIELDS IN QUESTION

In fact, what is at stake is the dual view which now takes place in physics since the 19th century and which asserts that there can be 2 equivalent points of view. The first one was Newton's point of view or even Galileo's point of view, which is dynamics. We can observe forces in our world and those forces operate so that some objects move. In the 19th century appeared the notion of fields and in my opinion there is a swindle at that point. Even Feynman however, says that the field approach is strictly equivalent to that of dynamics. We are going to see that this only is wishful thinking. Let us perform the reasoning with charged particles, but the same would remain true with gravitation.
We all know the Coulomb force which 2 charged particles exert on each other. It is given by the formula $F = \frac{qq'}{4\pi\varepsilon_0 r^2}$ with trivial notations. Such a force has been measured and cannot be questioned. Now, what the supporters of the field approach say, is that when a particle is charged, it creates a field around itself which is given by $E = \frac{q}{4\pi\varepsilon_0 r^2}$. All this seems good, but it is not. Let us consider, indeed, a particle, which is alone, that is it is alone in an isolated system. Then the theory says that it creates a field around itself. But, since by definition we are in an isolated system, there cannot be any experiment able to prove that such a field exists. In such a case, we cannot know anything about what there is around the particle. The only way to know is to inject another particle in the system, but then, the problem changes of nature. Moreover, physicists say there is a field around the particle, but they also say that its surroundings are made of vacuum. A priori, vacuum is the absence of everything. How can then mainstream physicists say that whereas there is nothing, there could be a field? What could such a field be if it is made of nothing?

3. INTERACTIONS

Pierre Poubeau, in his paper, has shown that there are some clues that interactions, in some cases, would be instantaneous. Following him, when we inject a charged particle in the neighbourhood of another charged particle, we expect to get an instantaneous action. However, we only know one case of potentially instantaneous action in physics; this is when 2 systems are entangled. I therefore strongly suggest considering, under the light of the preceding, that entanglement is a much more common phenomenon in nature than what we believed until now. I propose we consider any 2 charged particles as entangled wherever they are, but with a kind of entanglement which strength decreases with, say, distance, which potentially is a new kind of entanglement. In the end, I plead for a revolution in approaching entanglement, by considering it as a global phenomenon which can present several aspects

4. GRAVITATION

In this paragraph, I shall prove that the same swindle is ongoing in general relativity as the one which was committed with Maxwell equations. For this, let me write Einstein's equation in its form when using Ricci tensors. We get:

$$Ric_{\alpha\beta} - \frac{1}{2} g_{\alpha\beta} R_{scal} = T_{\alpha\beta}$$

Roughly speaking, the left side of the equation is the geometric tensor whereas the right side is the physical tensor. *Ric* is the Ricci tensor, *g* is the metric tensor and *R*, is the scalar curvature. What this equation means, is that mass, in its environment, is going to change the geometry. Now, until now, great effort has been done to solve the equation obtained when there is no mass. That is, great effort has been done in trying to solve:

$$Ric_{\alpha\beta} - \frac{1}{2} g_{\alpha\beta} R_{scal} = 0$$

Considering now such an equation, it is not very hard to prove that it is a wave equation like the wave equation obtained with Maxwell equations when $\rho = 0$ and $\vec{j} = \vec{0}$. Of course, its resolution is much more complicated due to the fact that we must work in a Riemannian geometry.

However, is such an equation legitimate? The answer clearly is no, for the same reason as the ones we had for Maxwell equations. Clearly, mass is, at a certain scale, a quantum magnitude, so that it is not continuous neither derivable. So we do not have the right to keep, on the left side, a continuous and derivable function while we tackle discreet behaviour on the right side of the equation and where derivatives of such a quantity appear.

5. NEW QUESTIONS

From the preceding, new questions arise. The first one is when we consider the equation $Ric_{\alpha\beta} - \frac{1}{2} g_{\alpha\beta} R_{scal} = 0$. Since it looks like the wave propagating equation of Maxwell, we could wonder if we could not consider the gravitation field as the combination of 2 orthogonal fields, propagating together in the same way as E and B in electromagnetism. Assuming that the gravitation field is one of these, what would the second field be? What would its nature be? What physical reality would it represent? What would signify the intermediary equations we would have with these fields since the propagation equation would be a combination of those more fundamental equations?

On the other hand, since we rather argued that fields only are a wit's view, there should not be any gravitation field, but, once again, gravitational entanglement with infinite propagation speed. Now, since we would therefore be in the same situation as with electromagnetism, we should look for thought experiments which give the same kind of contradiction to which Pierre Poubeau was brought, but now with gravitation. Hunting is open!

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