FUNDAMENTAL QUANTITIES

of Neoclassical Physics

EM potentials are introduced as the energetic medium disturbances, the fields – as their formal features, and carriers – as such features of these fields. The moving static form kinetic quantities, and accelerated – dynamic ones. In the three kinematical states, the three types of quantities are related by three pairs of differential equations. The two electric fields – static and dynamic – are unified in *rt*-planes. The kinetic forces are expressed by magnetic fields. The two potentials form a vector, fields – bi-vector, and carriers – tri-vector, in respective subspaces of 4D.

2.1 Introduction

The well-known ancient dilemma, of the *body* or *spirit* priority, is still not resolved. Instead of the religious preference of spirit, the profound investigation of living bodies is crowned by the genetic code resolution. In the new form, the dilemma is thus turned onto a new level of observation. At least tacitly, a *functional* explanation of spirit is now expected, alike the causal relation of *hardware* and *software* in informatics. On the other hand, genetic code may be understood as the catalogue number at the card file of the life library, in the mere *conventional* sense.

Similar is the physical dilemma of the *matter* or *energy* priority. Though sensory inaccessible, energy is universally conserved in the widest sense. On the other hand, the usual empirical evidence of matter is scientifically reduced to *mass*, as the imagined substance, responsible for the inertia and gravitation. Though dependent on speed and apt to some defect, or even – to annihilation, it is further valorized by prediction and alleged empirical verification of respective bosons. However, the question still remains: what makes these bosons to be inert and attractive?

These relations are further graduated in EM theory, by the three types of physical quantities: apart from material *carriers*, their *fields* and *potentials*. In the similar sense as mass, the concept of *electricity*, as the bipolar substance, is understood. The charged particles play the roles of the field *carriers*, with the potentials – as the energetic features of these fields. Having in view the *static* interactions, the *rigid* associated fields were

imagined, enabling the direct actions at all distances. Irrespective of principal views, this fact is implicitly understood in practice.

According to the two Thomson's algebraic relations (24), a moving field is producing the other, at each spatial point and temporal instant, irrespective of the carriers. In this way, the classical dilemma of the force transfer can be directly superseded. The differential analysis of the algebraic, gave differential sets [1] relating the two field derivatives with their imagined carriers. By direct introduction of two EM potentials, in this exposition, the essential physical relations will be brought to light, thus directly inverting the former hierarchy of EM quantities.

The static potential can be introduced as the electric medium disturbance around the apparent carriers. In parallel and conformity with electric currents, a moving static just represents respective kinetic potentials. The fields appear as the formal features of potentials, and their carriers – of these fields themselves. The potentials play the role of the primary, fields – of secondary, and carriers – of tertiary EM quantities. Though EM forces act from the fields, the particles are at least the centers, something as the knots of their fields, irrespective of own essences.

2.2 Duality or Trinity

The human *exile from paradise*, as the fall into the lower conscience, is expressed by thinking in the terms of typical oppositions, such as virtue and vice or light and dark. Instead of the holly or possible natural trinities, the existence is thus stretched between the body and spirit. An example of the opposite transition is that from the black-white techniques, in the terms of light intensity, into the circular color spectrum, strictly determined by the three basic colors. In a similar way, all physical forces can be classified into the *static*, *kinetic* and *dynamic* types.

In the sense of the usual example, we here mention the three phenomenal forces: *gravitational*, *centrifugal* and *inertial* ones. At least their scalar expressions operate by the *position*, *speed* and *acceleration*, respectively, of the observed massive bodies. The three kinematical states are mathematically arranged in the strict hierarchical sequence, determining the static, kinetic and dynamic quantities. Despite their energetic distinctions, the two latter reactions onto the variable motion are formally unified by the vector form of the *force action law*: $\mathbf{f} = -\partial(m\mathbf{v})/\partial t$.

The three established EM forces – *electro-static*, *magnetic* and *electro-dynamic*, respectively dependent on the position, motion and acceleration – but of electricity, are distinctly reduced. Unlike magnetic forces, affecting the moving charges only, the two remaining EM forces equally affect all the present electricity, including the field carriers themselves. Irrespective of their formal expressions, concerning the separate distinct fields, they are sweepingly unified and expressed by *combined* electric field, unlike magnetic one – affecting moving charges only.

2.3 Carriers or Potentials

The classical physics understood an invisible and impalpable vacuum medium, the substratum of physical fields and their waves, distinct from material bodies plunged into this medium. In the preference of material entities, the modern physics neglects or negates the medium, ascribing its deformations and disturbances to the empty space. As the synthesis, we point to electric processes at the medium, forming the particles. Irrespective of the vague notions of both – the medium and space, there is not irrelevant which of the two terms will be mentioned.

The equivalence of a fluid *pressure* and *energy density* may be extended to the expected *vacuum medium*. The *bipolar electric potential* around apparent particle, as the *cyclone* or *anti-cyclone* at the medium, is defined by the energy per an *object charge*: $\Phi = w/q$. Tending to the *homogeneous energy* distribution, the potential supplants similar objects and sucks opposite ones. Two equipolar charges thus mutually repel, but opposite ones attract each other. The energy of a given object charge at the foreign or its own potential is thus determined: $w = q\Phi$.

In parallel with *current*, as the moving *electricity* (37a), a moving *static* is proportional with *kinetic* potentials (38a). This definition also includes the two constants: apart from the pressure disturbance (Φ), the medium strains also depend on its *elasticity* (ε), as well as the moving mass – on its own *density* (μ). The kinetic potential thus reminds *linear momentum density*. Originations of the kinetic quantities give respective continuity equations (37b,38b). The common uniform motion reduces them to the *convective derivatives* of respective scalar fields.

$$\mathbf{J} = \mathbf{V}Q \qquad \nabla\cdot\mathbf{J} = Q\,\nabla\cdot\mathbf{V} + \mathbf{V}\cdot\nabla Q = -\partial_t Q \tag{37}$$

$$\mathbf{A} = \varepsilon\mu\mathbf{V}\Phi \qquad \nabla\cdot\mathbf{A} = \varepsilon\mu\mathbf{V}\cdot\nabla\Phi = -\varepsilon\mu\,\partial_t\Phi \tag{38}$$

These relations are easily acceptable in the case of *convective* currents, as the free electric charges moving through the free space. However, at the conductive and displacement currents, running through the neutral conductors or dielectrics, the moving electricity is statically compensated by the opposite polarity being at rest. Though not statically evident, it forms respective current manifest by magnetic field. The moving potential seems to be problematic in the technical approach to natural phenomena, relying on the physical quantities directly manifest.

In the quandary between the theory and practice, (37a) was somehow admitted. However, (38a) has not been formulated, let alone used so far. Its differential consequence (38b) was introduced, but rather intuitively, and adopted as the formal condition. We will soon show that (38a) enables the strict mutual relation of the known, as if independent classical laws. Thus starting by the two potentials, the two EM fields and their apparent carriers will be here introduced. Unlike their *empirical* introduction [1], the *rational* one includes the clearer interpretations.

2.4 Static Relations

The relation of some *energy* density and respective *force* field (13a) divided by the object charge defines the electric force field (39a). Its product with structural elasticity gives the rational field (**D**), as mutual *displacement* of the two structural polarities. The field terminals are understood as the charge density (39b). The displacement has started by this charge. The *electrical neutrality* of each 3D location is thus announced. With respect to the two electric polarities, as the opposite medium disturbances, it expresses the tendency to the energy homogeneity.

$$-\nabla \Phi = \mathbf{E} = \mathbf{D}/\varepsilon \qquad\qquad \nabla \cdot \mathbf{D} = Q \tag{39}$$

This neutrality was long ago verified in advance. Namely, some electric charge inserted into a closed metallic sphere polarizes all surrounding media, including vacuum and the metallic spherical walls. The attracted opposite electricity compensates the inserted charge, but its repelled polarity forms the outgoing flux of displacement (40a). Discharging the external surface charge, Faraday established its strict equality with the inserted value, thus confirming the neutrality. The opposite disturbances of various structural strata compensate each other [3].

$$\mathbf{D} = q\mathbf{r}_o/4\pi r^2 \qquad\qquad \Phi = q/4\pi\varepsilon r \tag{40}$$

The radial field around a charge (40a) is evenly distributed about each concentric sphere. The total field flux equals to the carrying charge. Gaussian integral and Maxwell's differential equations are the direct consequences. Coulomb's law expresses the tendency to the material neutrality, concerning the charged particles. The full neutrality is completed by the medium disturbance, in the form of electric field (40a). Its radial integral gives the static potential (40b). This first-degree inverse function points to its cylindrical distribution around the *t*-axis.

2.5 Kinetic Relations

Alike the kinetic forces at fluids [10], transverse heterogeneities of the kinetic potential are manifest by similar forces. The *transverse gradient* of this potential, expressed by its *circulation*, is named as the magnetic field (41a). Its vacuum component, as respective rational field, depends on the density ratio of the structural strata. Its own circulation accords with electric currents (41b), including motion of the free and bound electricity. With respect to (38a), the algebraic relation (42) is obtained, enabling the confirmation (30) of the kinetic equation (41b).

$$\nabla \times \mathbf{A} = \mathbf{B} = \mu \mathbf{H} \qquad\qquad \nabla \times \mathbf{H} = \mathbf{J} + \partial_t \mathbf{D} \tag{41}$$

$$\mathbf{H} = \varepsilon \left(\Phi \, \nabla \times \mathbf{V} - \mathbf{V} \times \nabla \Phi \right) = \mathbf{V} \times \mathbf{D} \tag{42}$$

Apart from the electric field (39a), as the *radial* gradient of the static potentials, magnetic field expresses the *transverse* gradient of the kinetic potential (41a). However, unlike the electric field lines – *opposite* to the radial gradient, magnetic ones form the *equipotential surfaces*, *perpendicular* to the transverse gradient. Therefore, these lines are the closed spatial contours, with exclusively vortical form of the magnetic fields. In this sense, the origination of (41a) gives the *trivial equation* (28), excluding the divergent magnetic fields and their free carriers.

$$\mathbf{A} = \mu q \mathbf{V} / 4\pi r \qquad\qquad \mathbf{H} = q \mathbf{V} \times \mathbf{r}_o / 4\pi r^2 \tag{43}$$

The relations (38a) & (42) applied to (40b) & (40a) – respectively, gives the kinetic potential (43a) & magnetic field (43b) around a moving charge. The field direction is determined by the cross product of the speed and radius. The axial kinetic potential is traced by circular magnetic field. By the analytical procedure (41a), these two results can be directly related. The two elementary EM fields and respective potentials (40,43), or their

arbitrary integral superpositions, strictly obey all the general field relations, already well-known or merrily here introduced.

2.6 Dynamic Relations

With respect to the general neutrality, certain acceleration of the material charges demands the opposite acceleration of surrounding electricity. With respect to force action law, with Einstein's and Maxwell's relations (131), this reaction is manifest as the *induced* electric field (44). Taking into account (38a), the *dynamic* induction (45a) is obvious. Its circulation, with substitution of (41a), gives the dynamic equation (45b). Starting by the two potentials, the complete Maxwell's set is here obtained, also including, already above mentioned, his trivial equation.

$$\mathbf{E} = \frac{\mathbf{F}}{q} = -\frac{\partial(\mathbf{V}m)}{q\partial t} = -\frac{\partial(\mathbf{V}w)}{q\mathrm{c}^2\partial t} = -\varepsilon\mu\frac{\partial(\mathbf{V}\Phi)}{\partial t} \tag{44}$$

$$\mathbf{E} = -\partial_t\mathbf{A} \qquad\qquad \nabla\times\mathbf{E} = -\partial_t\mathbf{B} \tag{45}$$

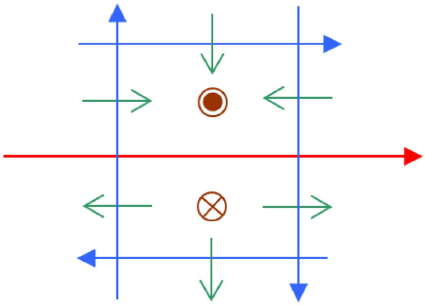
The three *relevant* Maxwell's equations, relating the two EM fields with their carriers, are already causally preceded by that relating the potentials with fields. There appears at least the formal hierarchy: from the potentials, via fields, up to carriers. Alike the fields, as the formal features of the potentials, carriers are similar features of these fields. The three levels of this consideration (static, kinetic & dynamic) are conditioned by the *presence*, *motion* and *acceleration*, respectively, of the three types of static quantities: the potentials, fields and their carriers.

2.7 EM Forces

The *static* electric field is conditioned by electricity, but *dynamic* – by its acceleration. Thus affecting the same objects by the forces in their directions, they are taken as the *unique* electric field, $\mathbf{E} = \mathbf{F}/q$, in the *combined* form. On the other hand, the *kinetic energy* of a moving charge at a *foreign* kinetic, is expressed by the *equivalent* static potentials (46). Here $\Phi_{\mathrm{eq}} = -\mathbf{v}\cdot\mathbf{A}$ denotes this potential, and $\mathbf{j} = q\mathbf{v}$ – the object current. Parallel currents mutually attract by the decreased transverse pressures, but opposite ones repel by the kinetic vortices in between.

$$w_{\mathrm{k}} = q\Phi_{\mathrm{eq}} = -q\mathbf{v}\cdot\mathbf{A} = -\mathbf{j}\cdot\mathbf{A} \tag{46}$$

By the both mentioned effects, two crosswise currents tend to the same courses, thus exceeding the dot product (46). Therefore, this equation is not completely adequate. The equivalent electric field (47), restricted to the uniform motion, is reduced to the two terms. The former term, as the *relative derivative* of the potential, is annulled – at the longitudinal, but is opposite to the latter term – at transverse currents. Without it, the last cross product determines the circular object motion, according to the experience and this figure.



$$\mathbf{E}_{\text{eq}} = \mathbf{v}\cdot\nabla\mathbf{A} + \mathbf{v}\times\nabla\times\mathbf{A} = (\partial_t\mathbf{A}) + \mathbf{v}\times\mathbf{B} \tag{47}$$

Apart from the presented reduction of the equivalent electric field, the same result can be *rationally* confirmed by the consideration of displacement currents around a moving charge [8]. The reduced equivalent field may be substituted by the line charge (48), as if distributed on the axis of the circular motion. The two final terms, as the fractions, depend on the object circulation and carrying current, respectively. Unlike a *central* electric carrier, with *radially* divergent field (40a), this one seems to be distributed axially, with the field *transversely* divergent.

$$Q_{\text{eq}} = \varepsilon\nabla\cdot\mathbf{E} = \varepsilon\mu(\mathbf{H}\cdot\nabla\times\mathbf{v} - \mathbf{v}\cdot\nabla\times\mathbf{H}) \tag{48}$$

2.8 4D Relations

Amongst the three types of EM quantities, the potentials consist of 3+1, fields – of 3+3, and their carriers – of 3+1 components. These numbers accord with the *four* axes, *six* planes and *four* 3D subspaces, respectively, in 4D. Starting by the potentials, as 4D vector, the fields – as bi-vector and carriers – as tri-vector, are already obtained by the successive differentiation. From the above Maxwell's equations, Riemann directly related the potentials with their carriers (49), as the vector and tri-vector. With respect to (37a,38a), these two equations are equivalent.

$$\varepsilon\mu\partial_t^2\Phi - \Delta\Phi = Q/\varepsilon \qquad\qquad \varepsilon\mu\partial_t^2\mathbf{A} - \Delta\mathbf{A} = \mathbf{J}\mu \tag{49}$$

The static and dynamic electric fields as if form the circular vortices of the kinetic potential (50), at least in the particular *rt*-planes. The metrical sense of temporal axis is understood in 4D. The needed condition, $\Phi = -A_t$, as (38a) in the *natural units* ($-V = \mathrm{c} = 1$), points to the causal feedback, producing the static quantities. The static potential thus appears as a negative projection of the temporal kinetic one. Unlike the perpendicular *axial* vector of magnetic field (43b), the *polar* vector of electric field acts along the vortex gradient at respective *rt*-plane.

$$\mathbf{E} = -\nabla\Phi - \partial_t\mathbf{A} = (\partial_r A_t - \partial_t A_r)\mathbf{i}_r \tag{50}$$

2.9 Summary

Instead of the two parallel Maxwell's pairs, the sequence of their three pairs is here emphasized. The parallelism of the quantities and equations is thus substituted by their two-directional hierarchy. The sequence of the potentials, fields and carriers is just opposite to that already implicitly understood, but this one of the static, kinetic and dynamic processes has not been clearly emphasized so far. The static (divergent) and dynamic (vortical) electric fields are unified in *rt*-planes. Their forces distinguish from magnetic ones, determined in the spatial domain.

Starting by the two potentials, the *fluidic interpretation* of EM quantities and interactions is obtained. The static, kinetic and dynamic forces are explained just on this basis. The substitution of respective forces and energies mutually relates the mechanical and EM dynamic laws. By the direct consequence, mass is related with electricity: $m = w/\mathrm{c}^2 = \varepsilon\mu q\Phi$. Irrespective of their similarities or distinctions, Einstein's and Maxwell's relations supplement each other. The detailed reduction of the mechanical laws to EM forces will be considered in [6].

Expecting material field carriers – independent of the medium, Maxwell predicted the successive transfer through space of all their interactions. Concerning the fields variable in time, this view was covered by the predicted EM waves and their speed. Their practical confirmation enabled the wide acceptance of Maxwell's theory, including successive transfer of all physical forces. It is nowadays illustrated by mutual exchange of photons between interacting particles. However, at least the attractive forces cannot be interpreted by this formal concept.

On the other hand, the stationary fields, independent of time, do not imply any time for the force transfer. Maxwell's opponents thus advocated

the direct interaction at all distances, but without any interpretation. The two Thomson's relations, understanding the direct field interactions irrespective of their apparent carriers, here explain this view. EM potentials, as the primary medium disturbances, interact directly by their gradients, at each spatial point and temporal instant separately. The classical dilemma is thus finally and convincingly superseded.

2.10 Conclusion

The *inductive* development of physics started by the evident forces between assumed particles. Each new step in this approach was hypothetical in some extent, and respective detour proofs followed into theoretical dead ends, with possible formal mistakes or omissions. The concept of energy, providing the transparent and convincing *deductive* exposition, appears as more essential. Not only that all the quantities and their relations form a solid scientific system, but the forces are reduced to fluid mechanics, and respective equations derived by the analogies.