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EQUATIONS OF ELECTRODYNAMICS

1. Standard Central Laws
(operating by discrete quantities)

On the golden memorial table of Cavendish laboratory, under the title "*And got sad*..." four Maxwell's equations are written. However, *in the beginning was Coulomb's law!* It treats the static interaction of two electric charges. This law, equivalent with one of the equations, may be considered as a fundamental corner stone of the building known as EM theory, finally covered by Maxwell's equations. The analogous interaction of magnetic poles plays the role of another stone. By introduction of EM fields, as the intermediate quantities, these laws are split into the laws of force action upon the *objects* and field distribution around respective *carriers*.

Symmetric Interactions	Unilateral Force Actions	Central Field Distribution
$\mathbf{f}_{es} = a\, q_1 q_2 \mathbf{r}_o / r^2$	$\mathbf{f}_{es} = q_2 \mathbf{E}$	$\mathbf{E}_s = a\, q_1 \mathbf{r}_o / r^2$
$\mathbf{f}_{mk} = -\, b\, (\mathbf{j}_1 \cdot \mathbf{j}_2) \mathbf{r}_o / r^2$	$\mathbf{f}_{mk} = q_2 \mathbf{v} \times \mathbf{B}$	$\mathbf{B}_k = b\, q_1 \mathbf{V} \times \mathbf{r}_o / r^2$
$\mathbf{f}_{ms} = b\, p_1 p_2 \mathbf{r}_o / r^2$	$\mathbf{f}_{ms} = p_2 \mathbf{B}$	$\mathbf{B}_s = b\, p_1 \mathbf{r}_o / r^2$
$\mathbf{f}_{ek} = -\, b\, (\mathbf{k}_1 \cdot \mathbf{k}_2) \mathbf{r}_o / r^2 c^2$	$\mathbf{f}_{ek} = \mathbf{E} \times \mathbf{u} p_2 / c^2$	$\mathbf{E}_k = b\, \mathbf{r}_o \times \mathbf{U} p_1 / r^2$

$$a = 1/4\pi\varepsilon,\ b = \mu/4\pi,\ a/b = 1/\varepsilon\mu = c^2,\ \ \mathbf{j}_1 = q_1 \mathbf{V},\ \ \mathbf{j}_2 = q_2 \mathbf{v}\ \ \ldots$$

The two static EM fields are mutually exclusive: each of them affects its own objects only. At motion of a carrier the unlike field is produced, affecting respective objects. At simultaneous motion of two like carriers they interact additionally, by the other fields. The kinetic interaction of two moving charges has not been so far finally resolved. Respective laws of action and distribution have been introduced in ıdvance, on the empirical bases. The elimination of the magnetic field, via doable vector product, gives the two force terms: radial and ıxial. The latter of these interactions as if produces the torque upon he moving dipole, as an isolated physical system. It also could not be neasured in the Trouton-Moble experiment. The radial transverse component is used for definition of the unit of electric current.

The three symmetric laws treating moving magnetic poles are ntroduced here, thus completing the four fundamental corner stones of EM theory. The generalization of the four distribution laws, by an nfinitesimal procedure and superposition, turn them into the known ntegral laws of electrodynamics, otherwise obtained empirically.

2. Primary Field Induction (unlike carriers interaction)

The comparisons of the static and kinetic fields around the same carriers gives the two equations of J. J. Thomson. They express the *real unlike* fields affecting respective objects. Instead of usual field variation, they treat the field motion, not always manifested through respective variation. The symmetric forces, caused by motion of the *unlike* objects, are expressed through respective *virtual* fields, not really present in the medium. They equivalently substitute the real *like* fields. The two respective equations are obtained by equalization in he pair of the static and kinetic forces mutually unlike.

Full Mixed Interactions	Virtual Fields	Real Fields
$\mathbf{E} = (\mathbf{v} - \mathbf{U}) \times \mathbf{B}$	$\mathbf{E} = \mathbf{v} \times \mathbf{B}$	$\mathbf{H} = \mathbf{V} \times \mathbf{D}$
$\mathbf{H} = (\mathbf{V} - \mathbf{u}) \times \mathbf{D}$	$\mathbf{H} = \mathbf{D} \times \mathbf{u}$	$\mathbf{E} = \mathbf{B} \times \mathbf{U}$

The cross union of the respective real and virtual fields gives the full interaction of a carrier and its unlike object. These two equations express the same summary interaction, with opposite roles of the carriers and objects. The former of them is usually used in the classical EM theory. However, in the case of a measuring receptor moving through the moving fields – as their common object (**u** = **v**), the two equations have their independent senses.

3. Secondary Field Induction
(like carriers interaction)

As the result of some combination of the primary, there arise the two types of some secondary induction. The motion of the objects through unlike fields already really induced produces the transverse virtual, and motion of these fields themselves – the longitudinal real induction. The velocity of a primarily induced field is obtained as the result of zero axial component of the kinetic interaction. They both added to the static interactions give the full transformation of each field separately. Unlike the primary induction having the relative sense, these ones do not annul at the common motion. The relativity principle is not valid in the case of the like moving carriers.

Full Field Transformation	Transverse Virtual Induction	Longitudinal Real Induction
$\mathbf{E}'' = (1 - V^2/c^2)\,\mathbf{E}$	$\mathbf{DE}_t = -\,\varepsilon\mu\, Vv \sin\theta\, \mathbf{E}$	$\mathbf{DE}_l = -\,\varepsilon\mu\, V^2 \cos\theta\, \mathbf{E}$
$\mathbf{H}'' = (1 - U^2/c^2)\,\mathbf{H}$	$\mathbf{DH}_t = -\,\varepsilon\mu\, Uu \sin\theta\, \mathbf{H}$	$\mathbf{DH}_l = -\,\varepsilon\mu\, U^2 \cos\theta\, \mathbf{H}$
$(v = V, \quad u = U)$	(θ - polar angle)	$(U' = V \mathit{ctg}\, \theta$

The symmetric full transformations maintain the even radial extension acting upon the surface of the moving practice, obviously decreasing by the speed. This causes the decreasing of its radius, and respective increasing of EM mass, just in the accord to the Lorentz' "relativistic" formula. On the other hand, the longitudinal real induction squeezes the equipotential surfaces from the direction of the motion. Unlike relativistic increasing of the transverse, this is result of the decreasing of the longitudinal field component.

4. Alternative EM Laws
(in the terms of energy)

Unlike the standard interactions given in the terms of the forces, the integration along the radius turns them into respective alternative laws, operating by potential energies. The splitting of the former pair defines the scalar – electric, and “magnetic” vector-potential. They are the bases for derivation of the alternative equations, mutually relating the two potentials, similarly as respective EM fields.

Symmetric Interactions	Energies and Potentials	Alternative Equations
$w_{es} = a\, q_1 q_2 / r$	$w_{es} = q_2 Y$	$\mathbf{A} = \varepsilon\mu\, Y\mathbf{V}$
$w_{mk} = b\, (\mathbf{j}_1 \cdot \mathbf{j}_2)/r$	$Y = a\, q_1/r$	$Y = -\,\mathbf{A} \cdot \mathbf{U}$
$w_{ms} = b\, p_1 p_2 / r$	$w_{mk} = -\,\mathbf{j}_2 \cdot \mathbf{A}$	$\mathbf{J} = QV$
$w_{ek} = b(\mathbf{k}_1 \cdot \mathbf{k}_2)/rc^2$	$\mathbf{A} = b\, \mathbf{j}_1/r$	$Q = \varepsilon\mu\, \mathbf{J} \cdot \mathbf{U}$

The substitution of the two central potentials into their mutual relations respectively relates their material carriers. Unlike the quantum electricity, some charge – equivalent to respective non-vortical electric field really induced – may be obtained by the longitudinal motion of a line conductor carrying electric current.

5. Classical Analytical Equations
(relating distributed fields)

Let us return to the laws of central field distribution. By division of a static field into infinite number of solid angles, or kinetic fields – into plane angles, enables their generalization to any closed surface or contour, respectively. The superposition of many discrete charges or currents enables generalization to the distributed carriers. These two types of operations directly give the four integral laws.

Integral EM Laws	Maxwell´s Equations	Tensor Relations
$\iint \mathbf{D} \cdot d\mathrm{s} = \iiint \mathrm{Q}\, d\mathrm{v}$	$div\ \mathbf{D} = \mathrm{Q}$	$\sum_n \partial_n (\mathrm{HD})_{mn} = \mathrm{J}_m$
$\int \mathbf{H} = \iint (\partial\mathbf{D}/\partial t + \mathbf{J}) \cdot d\mathrm{s}$	$rot\ \mathbf{H} = \partial\mathbf{D}/\partial t + \mathbf{J}$	$\sum_n \partial_n (\mathrm{EB})_{mn} = 0$
$\iint \mathbf{B} \cdot d\mathrm{s} = 0$	$div\ \mathbf{B} = 0$	$(n \neq m)$
$\int \mathbf{E} = -\iint \partial\mathbf{B}/\partial t \cdot d\mathrm{s}$	$rot\ \mathbf{E} = -\, \partial\mathbf{B}/\partial t$	

Maxwell generalized these laws into their differential form, more mathematically operative, and Einstein turned them into very concise componental tensor form. With respect to the same origins, the last relations are fully equivalent to Thomson's algebraic equations.

6. Differential Forms (equivalence additionally confirmed)

In a cross sense, this equivalence may be confirmed on the differential level, by application of the differential operators to the algebraic equations, with further arrangement and reduction. The alternative relations are thus turned into Thomson’s standard – algebraic, and these into Maxwell’s differential equations.

Alternative- -Standard Relation	Algebraic- -Differential Relation	Accessory Differ. Forms
$rot\ \mathbf{A} =$	$div\ \mathbf{H} = \mathbf{D} \cdot rot\ \mathbf{V} - \mathbf{V} \cdot rot\ \mathbf{D}$	$\partial\mathbf{D}/\partial t = (\mathbf{D} \cdot \nabla)\mathbf{V} - div\ (\mathbf{VD})$
$= \varepsilon\mu\ (\mathrm{Y}\ rot\ \mathbf{V} - \mathbf{V}\ grad\ \mathrm{Y})$	$rot\ \mathbf{H} = div\ (\mathbf{DV}) - div\ (\mathbf{VD})$	$\partial\mathbf{B}/\partial t = \ldots$
$grad\ \mathrm{Y} = (\mathbf{A} \cdot \nabla)\mathbf{U} + (\mathbf{A} \cdot \nabla)\mathbf{U} +$	$div\ (\mathbf{DV}) = \mathbf{V} div\ \mathbf{D} + (\mathbf{D} \cdot \nabla)\mathbf{V}$	$\partial\mathbf{D}'/\partial t = \partial\mathbf{D}/\partial t + (\mathbf{v} \cdot \nabla)\mathbf{D}$
$+ \mathbf{A} \times rot\ \mathbf{U} + \mathbf{U} \times rot\ \mathbf{A}$	$div\ \mathbf{E} = \ldots \quad rot\ \mathbf{E} = \ldots$	$\partial\mathbf{B}'/\partial t = \ldots$

The former accessory differential forms represent the 5D equations of continuity of the two vector fields, and the latter are the virtual transformations of their time derivatives. The former forms are used here, and the latter – in the following consideration.

7. Hertz´ Eqs or Diff. Transformations (completed and elaborated)

The application of the virtual transformations – of the two vector fields, their time derivatives and respective carriers – onto the four Maxwell's equations gives the same these equations with the primed quantities. This shows the classical invariance of their mathematical form, usually denied in the relativistic considerations.

Virtual Field Transformations	Differ. Transform. Completed	Differ. Transform. Elaborated
$\mathbf{E}' = \mathbf{E} - \mathbf{B} \times \mathbf{v}$	$div\ \mathbf{E}' = Q/\varepsilon - div\ (\mathbf{B} \times \mathbf{v})$	$div\ \mathbf{D}' = Q - \varepsilon\mu\ \mathbf{v} \cdot rot\ \mathbf{H}$
$\mathbf{H}' = \mathbf{H} + \mathbf{D} \times \mathbf{v}$	$div\ \mathbf{H}' = div\ (\mathbf{D} \times \mathbf{v})$	$div\ \mathbf{B}' = \varepsilon\mu\ \mathbf{v} \cdot rot\ \mathbf{E}$
$Q' = Q - \varepsilon\mu\ \mathbf{J} \cdot \mathbf{v}$	$rot\ \mathbf{E}' = -\partial\mathbf{B}/\partial t - rot\ (\mathbf{B} \times \mathbf{v})$	$rot\ \mathbf{E}' = -\partial\mathbf{B}/\partial t - rot\ (\mathbf{v} \cdot \nabla)\mathbf{B}$
$\mathbf{J}' = \mathbf{J} - Q\ \mathbf{v}$	$rot\ \mathbf{H}' = \partial\mathbf{D}/\partial t + rot\ (\mathbf{D} \times \mathbf{v}) + \mathbf{J}$	$rot\ \mathbf{H}' = \partial\mathbf{D}/\partial t + (\mathbf{v} \cdot \nabla)\mathbf{D} +$
	$(\mathbf{u} = \mathbf{v})$	$+ \mathbf{J} + \mathbf{v}\ div\ \mathbf{D}$

In the former step the two *rot*-equations, known as Hertz' ones, are supplemented by respective *div*-transformations. In the latter step they all are elaborated by expanding of the differential forms.

8. Conclusion

Apart from completion of the central laws, as the fundament of the theory, EM fields, respective potentials and their carriers are related algebraically. These relations may be considered as the walls of the theory. Beside original equivalence with the differential equations, the equivalence is confirmed on the higher level. These results firmly connect the walls of the theory with its cover, already well-known in the classics. Thus obtained solid scientific system enables the convincing uprooting of the relativistic transformations, respective problematic attitudes and inconsistent procedures of their derivation.