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The Structure of Ether

Felix F. Gorbatsevich
gorich@geoksc.apatity.ru

The principle of matter separation into opposites is universal. All that exists consists of two opposite elements. This philosophical principle also applies directly to ether. With this in mind, it should be expected that a vacuum, namely the ethereal medium, consists of two kinds of particles, charged positively and negatively. It is most probable, that these particles are of an electromagnetic nature. They are attracted to each other with great force. Let us try to construct a model of the ethereal medium, which would meet the phenomenon of a transverse nature when light and electromagnetic waves propagate. A string (filament) stretched in free space along a straight line can be an initial mechanical model for this purpose. The vibration theory for such strings is sufficiently well developed [1]. A flexible string can be presented as a set of unit masses, bound together themselves by rigid links. The rigidity applies to their unchangeable, constant length. Hinges permit the free motion of masses and links relative to each other, Fig. 1, shows the connecting links and masses.

Fig. 1. A flexible string consisting of masses, rigid links and hinges.

Given (If) a displacement (is given) to the initial point of the string, the perturbation will begin to propagate along its length. The displacement vector of this perturbation will be perpendicular to the string's linear direction, Fig. 2.

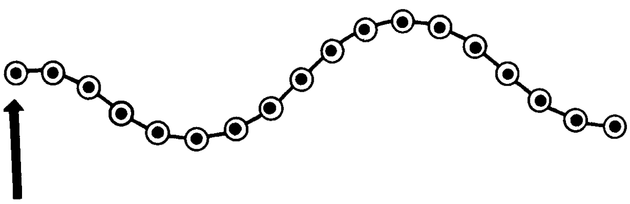

Fig. 2. Waves of a flexible string in free space.

It is necessary to note, that such a string in free space can only transmit waves with a displacement in the direction (across the line, along which) it is stretched. It cannot transmit oscillations of any other kind.

Note that as early as 1736, Johann Bernoulli Jr. published a work where he compared the waves propagating in the ether with lateral vibrations of a cord in tension which "being slightly pulled aside and then released makes lateral vibrations normal to the cord direction" [2].

If we connect a number of single strings together by transverse rigid links, also with hinges to connect the masses, it is possible to get a plane structure or a lattice consisting of masses and rigid links, Fig. 3.

A plane lattice, as well as the line in Fig. 1, arranged in the manner described, will only be capable of transmitting shear waves, Fig. 4.

The transition from the plane lattice to a spatial or volumetric (three-dimensional) one is easy to accomplish by adding the third coordinate to the lattice, Fig. 3, and locating the same rigid links, hinges and masses along this coordinate. Let us pay attention to the fact that in a spatial lattice, each mass (particle) contacts six other particles through rigid links. It is quite obvious that a spatial lattice consisting of the mentioned elements has the ability to transmit only shear waves. The direction of the displacement vector of these waves can be arbitrary in a spatial lattice.

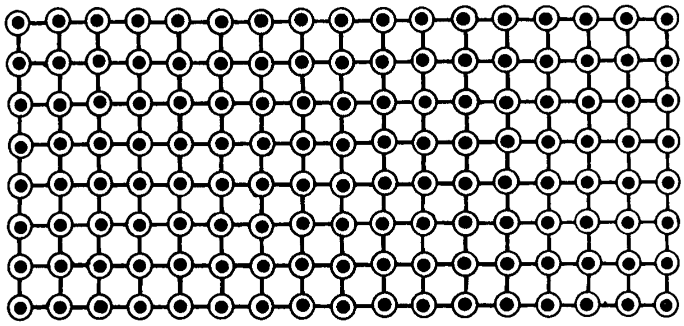

Fig. 3. A plane lattice consisting of unit masses, rigid links and hinges.

Now it is necessary to find a mechanism or some force, which would replace rigid links, but hold the elements of the spatial lattice together. In our opinion, an attractive force between particles of two opposite kinds, situated in the points of a regular lattice could suffice. Conventionally, they can be certain fundamental particles with (a) positive and negative charges, Fig. 5.

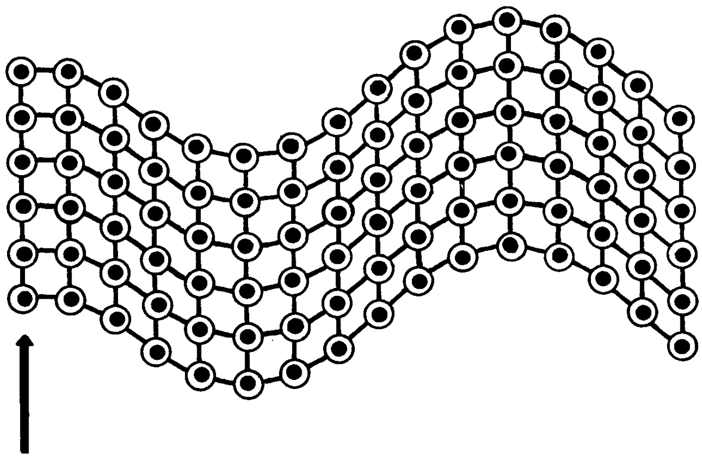

Fig. 4. A plane lattice transmitting shear waves.

In the figure, particles of two kinds, positive and negative, are represented as geometrically identical spheres in close contact. As will be shown below, the nature of their charges is electrical. (It is doubtless, that) For a spatial lattice formation, these fundamental particles must attract each other with a great force.

The model consisting of particles of two kinds, opposite in sign and in mutual attraction, explains many of the ethereal medium's properties. For example, it logically explains the exclusive homogeneity of the vacuum, correctly identified by J.C. Maxwell [3]. Really, a major attractive force among the particles will make them approach an analogue of an opposite kind. A process of attractive interaction and compensation for a particle's opposite charges will last until each particle of a particular sign is enclosed by six particles of the opposite sign. Thus, the structure of the ethereal medium will be strictly ranked and arranged as a regular spatial lattice.

Dislocations, originating in free ether for some reasons, will propagate from the place of their origin at the velocity of light *C*. As it was already shown above by the example of the most ancient Earth's rocks and meteorites [4], fundamental particles (electrons in orbits et al.) can move through the ethereal medium for vast distances and completely without friction. Accordingly, the particles of this medium (themselves) can also move relative to each other without friction.

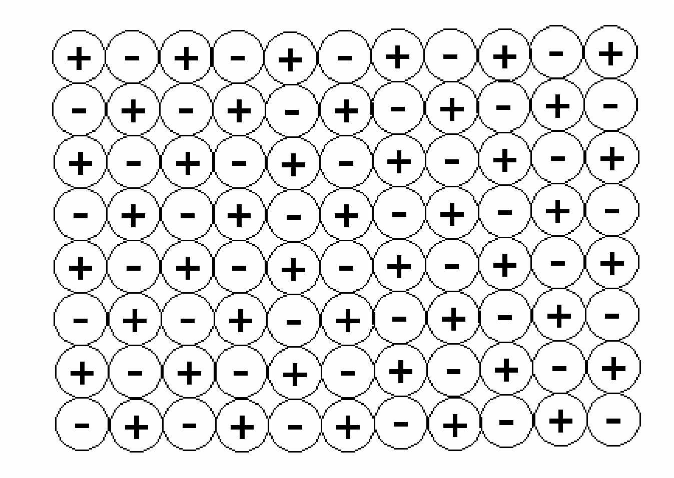

Fig. 5. The structure of the ethereal medium consisting of particles of two kinds, opposite in charge (projection on a plane).

The most visual idea of the perturbed ethereal medium is given by a magnetic field around a conductor with current or in the neighbourhood of a permanent magnet. Usually, a visualization of magnetic force lines is carried out with iron dust, Fig. 6.

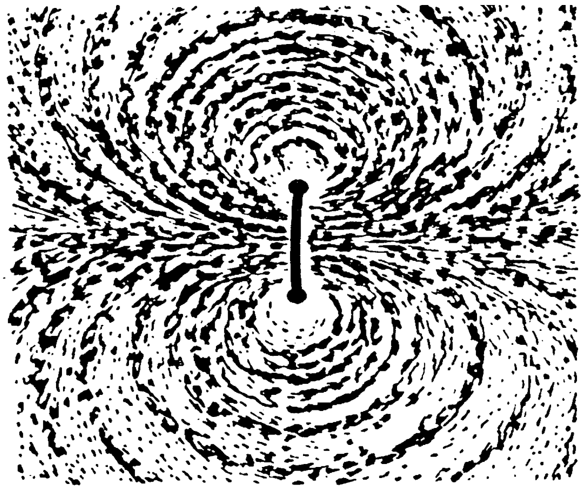

Fig. 6. Force lines of a magnetic field of circular current, traced through an iron dust.

The representation of a magnetic field as a shear strain of the ethereal medium is most logical. It eliminates a great number of contradictions. It is strictly proved that magnetic force lines are always closed. Equipotential lines of elastic shear strains are also always closed [5]. The so-called space continuity condition in this case is met. It should be supposed, that the space continuity condition is valid for the ethereal medium too. At the same time, the concept explaining the nature of a magnetic field by the presence of a vortex motion (for example, some particles) along a ring or other closed trajectories, requires a resolution of several contradictions.

First, the existence of unit material carriers of a magnetic field, which would be capable of moving only along closed trajectories, should be assumed. However, individual carriers of a magnetic field, for example, a Dirac monopole, has not been detected experimentally [6].

Second, individual field carriers, naturally, can move not only along closed trajectories. If such carriers of a magnetic field existed, they could accumulate at poles, similar to electrical charges and would be of a static nature. In such a case, they could easily be detected by experimental methods.

Third, in a vortical formation (population of enclosed and combined particles moving along closed trajectories particles in the medium), depending on the distance to the centre of rotation, a motion should arise with a different velocity. The velocity of particle motion is lower at the vortex periphery and rises in the direction of the centre. However by observations of the propagation of the magnetic component of radio waves with a different frequency in interplanetary space, it was determined that its velocity is close to a constant, namely to the velocity of light propagation *C* [7].

From the mechanics of moving media it is also known, that a vortex cannot be formed from particles moving with identical velocity, as for each of the rings enclosed in the vortex, the laws of equality of momenta and continuity of medium should be observed. Besides, it is extremely difficult to imagine and mathematically model closed streams of such particles without the formation of local vortexes, instabilities, different shapes of laminar, turbulent and other kinds of motion. As is known, just the instability of motion is typical of streams of actual fluids, especially including superfluids.

It would be possible to conceive of magnetic monopoles as waves moving around a conductor with current. However in this case, as well, a contradiction arises: only the light velocity *C* is the allowed for the velocity of waves propagating in ether, and it is close, as is known, to a constant. Thus, a magnetic wave, which circulates around a conductor with current, with a different velocity, depending on the distance to the conductor, cannot exist.

An exposition of the magnetic field near a permanent magnet by a static shear, torsional strain of the ethereal medium is much closer to the nature of the observable phenomenon. Thus, a model of the vacuum composed of geometrically equal particles with opposite charges represents a continuous medium in which only shear, torsional strains and shear, torsional waves are possible. The mathematical concept of a similar medium was developed as early as the 19th century.

As early as 1839 on the basis of the usual theory of elasticity MacCullagh [2] developed concepts of the ethereal medium which appeared to be in agreement with the theory of electromagnetic and optical phenomena put forth by J.C. Maxwell (1876). Below, the equations of MacCullagh are given mainly in Arnold Sommerfeld's presentation [8]. In the theory of the continuum, displacements, gyrations and strains are usually considered. An elastic body reacts to a strain by the rise of a tensor of elastic forces, the strains are also described by a tensor. Now let us imagine a "quasi-elastic" body, which is unreceptive to compression-tensile strains, but reacts to torsional strain relative to absolute space. A mathematical description of such shear strains can be given by an antisymmetric tensor as strains applied to a unit cube:

$$\begin{pmatrix} 0 & \sigma_{xy} & \sigma_{xz} \\ \sigma_{yx} & 0 & \sigma_{yz} \\ \sigma_{zx} & \sigma_{zy} & 0 \end{pmatrix}, \qquad (1)$$

where $\sigma_{ik} = -\sigma_{ki}$.

The relation between a rotation and strains are shown in Fig. 7. The elementary volume $\Delta\tau$ is turned by the (an) angle (of) φ_z (an arrow around the positive direction of the *z*-axis, according to the rule of the right-handed screw).

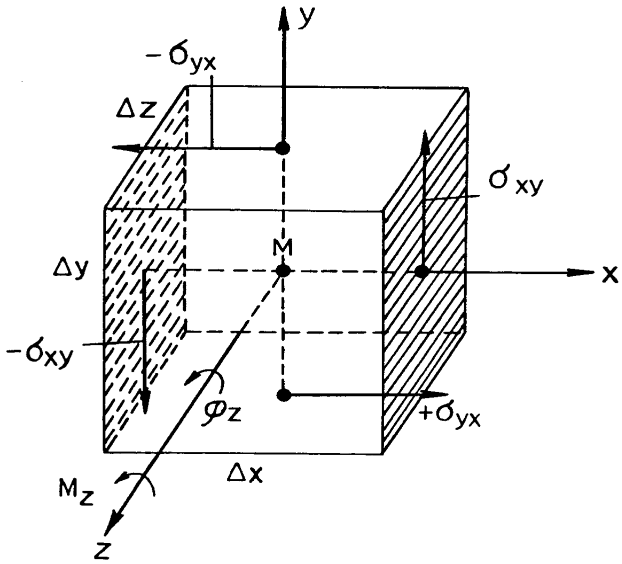

Fig. 7. Relation between strains and twisting moment in a quasi-elastic body.

To realize such torsion it is necessary to apply a moment of force around the z-axis:

$$M_z = k\varphi_z \,\Delta\tau, \qquad (2)$$

where k is the "torsion modulus" of a quasi-elastic body. Two shearing forces σ_{xy} and σ_{xy} designated in the figure, in the x- and y-planes, plotted on the axes x and y in positive directions and antiparallel forces in the relevant planes along the axes in negative directions, correspond to this moment of force. To observe a correspondence between (1) and (2) we should get

$$\sigma_{xy} = -\,\sigma_{yx} = (k/2)\varphi_z. \qquad (3)$$

As a result we obtain the moment operating in both x-planes:

$$2\sigma_{xy}\Delta y\Delta z(\Delta x/2) = (k/2)\varphi_z\Delta\tau$$

and the moment operating in two y-planes

$$-\,2\sigma_{yx}\Delta x\Delta z(\Delta y/2) = (k/2)\varphi_z\Delta\tau,$$

as well as the moment from equation (2).
The cyclical substitution from (3) explicitly leads to the following expressions:

$$\sigma_{yz} = -\,\sigma_{zy} = (k/2)\varphi_x, \qquad \sigma_{zx} = -\,\sigma_{xz} = (k/2)\varphi_y\,. \qquad (3a)$$

The action of forces, given in Fig. 7, can be represented schematically as those applied to an infinitesimal material point, situated inside a certain body.

It is possible to write down the motion equations of this quasi-elastic body by analogy with the known motion equations from the theory of elasticity [5]. Compiling them, we should take into account inertia (δ - is the mass of a unit volume) and consider only conventionally slow motions. Besides, we should abandon exterior forces (P = 0). Then, taking into account (3) and (3a), we get

$$\delta\frac{\partial u}{\partial t} = \frac{\partial\sigma_{yx}}{\partial y} + \frac{\partial\sigma_{zx}}{\partial z} = -\frac{k}{2}\left(\frac{\partial\varphi_z}{\partial y} - \frac{\partial\varphi_y}{\partial z}\right).$$

The latter, cyclically converted and vectorial written, represents an equation of motion

$$\delta\frac{\partial\vec{S}}{\partial t} = -\frac{k}{2}rot\vec{\varphi}. \qquad (4)$$

This equation can be represented in another way, using the ratio between $\vec{S}$ and the angular velocity ϖ. It will happen, if here, we exchange $d\varphi/dt$ for $\partial\varphi/\partial$ too

$$\delta \frac{\partial \vec{\varphi}}{\partial t} = \frac{1}{2} rot\vec{S}. \tag{5}$$

Based on assumptions of medium incompressibility for the value of $\vec{\varphi}$, - i.e. the angle of rotation of the displacement vector, we shall add the following condition:

$$div\vec{S} = 0, div\vec{\varphi} = 0. \tag{6}$$

According to A. Sommerfeld [8], the set of equations (4), (5) and (6) demonstrates a convincing simplicity and symmetry. It has the same shape, as equations of J.C. Maxwell for vacuum.

For more detailed investigation we shall introduce an electric field strength $\vec{F}$, a magnetic intensity $\vec{G}$, the constants of proportionality α, β, whose dimensions will depend on a choice of a physical quantities system, in which $\vec{F}$ and $\vec{G}$ are expressed and also on the sign before the magnetic field charge and force:

a) $\vec{S} = \pm\alpha\vec{F}$, $\quad \vec{\varphi} = \pm\beta\vec{G}$,

or b) $\vec{S} = \pm\alpha\vec{G}$, $\quad \vec{\varphi} = \pm\beta\vec{F}$.

Then identically to equations (4), (5) and (6) we shall receive the following twice:

$$\varepsilon_0 \frac{\partial \vec{F}}{\partial t} = rot\vec{G}, \qquad div\vec{F} = 0,$$
$$\mu_0 \frac{\partial \vec{G}}{\partial t} = -rot\vec{F}, \qquad div\vec{G} = 0. \tag{7}$$

The abbreviations introduced here ε_0, μ_0 are termed dielectric and magnetic permeability of the vacuum. In the system of our designations they will be given via:

$$\varepsilon_0 = \frac{\delta}{k}\frac{2\alpha}{\beta}, \quad \mu_0 = \frac{2\beta}{\alpha}, \tag{7a}$$

$$\mu_0 = \frac{\delta}{k}\frac{2\alpha}{\beta}, \quad \varepsilon_0 = \frac{2\beta}{\alpha}. \tag{7b}$$

Their product is irrespective of the choice of a system of units (the coefficients α, β). In both cases, this product will be equal to:

$$\varepsilon_0\mu_0 = \frac{4\delta}{k} = \frac{1}{C^2}. \tag{8}$$

Thus, the particular value of C means the velocity of propagation in vacuum. Let us take note, that just as the Newtonian definition of velocity is bound up with the concept of elasticity, so C is bound with the torsion modulus k.

In a ponderable dielectric the same basic equations (7), as in vacuum, operate only with the changed values of ε, μ, instead of ε_0, μ_0.. However, both conditions of divergence will vary essentially. Instead of $div\vec{G}$ = 0 there should be

$$div\,\boldsymbol{B} = 0, \text{ where } \boldsymbol{B} = \mu\vec{G} \text{ is magnet induction.} \tag{9}$$

This implies that a torsional deformation $\vec{\varphi}$ of a medium will be determined, not by the value of $\vec{G}$, but by the value of **B** creating no difficulties. On the other hand, the condition $\vec{F}$ = 0 will transform into

$$div\,\boldsymbol{D} = \delta_e, \quad \text{where } \boldsymbol{D} = \varepsilon\vec{F} \text{ is electrical strength,} \tag{10}$$

where δ_e is the spatial density of an operating electrical charge.

Since not $\vec{F}$, but $\vec{G}$ now determines the current velocity $\vec{S}$ and the constants ε, μ, are bound with k, δ, α and β, J.C. Maxwell's equations can be valid here too, in a ponderable dielectric. In the work [8] A. Sommerfeld writes that he is far from attaching any physical sense to this "model of ether". At the same time, the inclusion of the part about a model of quasi-solid ether into his fundamental work "Mechanics of deformable media" in the latest edition, which was issued in 1978, is rather significant.

The strain of the ethereal medium arising around the conductor with current, Fig. 6, most clearly demonstrates the validity and adequacy of MacCullagh's concept. Torsional strain forms a number of nested concentric surfaces. Each of these surfaces is equipotential within which a magnetic field intensity is a constant.

Our proposition that the ethereal medium, to some extent, is bound by great (according to astronomic scales) physical masses, corresponds to MacCullagh's earlier concept. In our opinion, the strains in the ethereal medium can be described by all tensor types in which diagonal terms, as in (1) are zero. This means that in the ethereal medium, strains of shape-changes, i.e. torsion, twisting and shear may exist.

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