Hydrodynamic Model of Electron Movement.

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A model is proposed in which an electron moves in a medium, or ether, which is assumed to fill all space. This model explains many 'relativistic' effects, plus the results of many experiments which are now explained in only an *ad hoc* manner, or are not explained at all.

Main Equation

Newton's second law was developed long before the science of electricity, and so may be considered valid for a neutral body. It makes force **F** equal to a mass m multiplied it's acceleration **a**:

$$\mathbf{F} = m\mathbf{a} \tag{1.1}$$

If one does not understand what force is, then this equation may be understood as the definition for force. On the other hand, in present-day physics there are many of different concepts of force: *i.e.* force as potential gradient, electrodynamics force, *etc*. Therefore, it is often convenient to believe that we know what force means, that the concept is given to us by Nature as a realization of a certain external action on the subject under consideration. If so, then (1.1) may be considered as a reaction of an electrically neutral mass m to an external action **F**: the mass gains acceleration **a**.

In modern physics, Eq. (1.1) is generalized to

$$\mathbf{F} = \frac{d}{dt}\left(m\mathbf{V}\right) = m\mathbf{a} + \frac{dm}{dt}\mathbf{V} \tag{1.2}$$

where **V** is particle velocity. The derivative dm/dt posses different physical meanings in different problems. In accord with the gravity concept proposed in [1], dm/dt in electrodynamics problems means the electron charge. One can find details of this concept in chapter 10 of [1]. So in electrodynamics, Eq. (1.2) appears as

$$\mathbf{F} = m\mathbf{a} + q\mathbf{V} \tag{1.3}$$

where q is the electron's charge and **V** is its velocity. The first term in (1.3) describes the neutral-mass reaction and the second term describes the charged-body reaction, its electric pliability. This term is defined by the viscosity of the medium in which the movement takes place.

Let us call this medium 'ether'. The term 'ether' is 'red flag' for many physicists, but whatever other terms may be used for it, like 'physical vacuum', *etc*., even the most orthodox physicists are compelled to agree that space is in fact filled with a certain medium. And I hope all my readers are agreed that this medium possesses electrical resistance. We know precisely what this resistance is: vacuum impedance $1/\varepsilon_0 c$, where ε_0 is dielectric constant and c is the speed of light.

External action cannot be exhausted by the two terms in (1.3). As occurs in all typical media, inertial forces of the ether should also be displayed. The idea that ether should resist movement of charged bodies (and light) has been asserted by many authors, among whom perhaps the most consistent (known to the author) are Russian scientists P.D. Prussov, and G.A. Shlenov.

But here we strive not for qualitative assertions, but rather for quantitative and testable statements. We try to find the quantitative formula describing the resistance. In accord with [1] and [2], let us suppose that medium inertial forces are proportional to ether impedance $1/\varepsilon_0 c$, and that the constant ε_0 means ether density. If one takes into account the dimensions of parameters, the inertial forces should also be proportional to speed squared, V^2. To be in accord with the experimental results, let us take the coefficient of proportionality equal to $1/2$. One finally gets:

$$\mathbf{F} = m\mathbf{a} + q\mathbf{V} - \frac{qV^2}{2c}\hat{\mathbf{V}} \tag{1.4}$$

where $\hat{\mathbf{V}}$ is a unit vector in the direction of velocity **V**.

In order to avoid useless complexity, the assertions following will be formulated in scalar form for a projection of the vector Eq. (1.4). Equations for other projections can be derived in an analogous way. One has:

$$\frac{dV}{dt} = \frac{F}{m} - \frac{qV}{m} + \frac{qV^2}{2mc} \tag{1.5}$$

Eq. (1.5) is first order with respect to V. Let us introduce the definitions

$$\frac{F}{q} = a,\ -1 = b,\ \frac{1}{2c} = p$$

Then Eq. (1.5) reduces to the form

$$\frac{dV}{dt} = \frac{q}{m}\left[a + bV + pV^2\right] \tag{1.6}$$

It is well known that Eq. (1.6) has a solution [3]. If $a + bV_0 + pV_0^2 \neq 0$, then the curve passing through point (t_0, V_0) is found as a solution with respect to V of the equation

$$\int_{V_0}^{V} \frac{dV}{\left(a+bV+pV^2\right)} = \frac{q}{m}\int_{t_0}^{t} dt \tag{1.7}$$

If

$$a+bV_0+pV_0^2=0 \tag{1.8}$$

then the straight line

$$V=V_0 \tag{1.9}$$

is a solution. Let us begin our analyses with solution (1.9). The solution of (1.8) is

$$V_0=\frac{-b\pm\sqrt{b^2-4ap}}{2p}$$

or taking into account our definitions

$$V_0=c\left(1\pm\sqrt{1-2F/qc}\right) \tag{1.10}$$

This equation has real solutions if

$$1-2F/qc\ge 0 \tag{1.11}$$

i.e. if force **F** is small enough. Force **F** which satisfies (1.10) has evident physical meaning: it preserves $\mathbf{V}_0$. If this force acts on electron already moving with velocity $\mathbf{V}_0$, that electron will continue moving with this velocity. This means that electron movement does not imply Newton's first law. Its movement is closer to that one of a car on the surface, or an airplane in the air.

If external force $\mathbf{F}=0$, then velocity

$$V=\frac{2cV_0}{\left[V_0+exp\left\{\frac{q}{m}(t-t_0)\right\}(2c-V_0)\right]} \tag{1.12}$$

i.e. velocity **V** exponentially decreases from achieved velocity $\mathbf{V}_0$ when there is no external force.

Case $1-2F/qc>0$. Subluminal Movement

Let us come back to (1.6) equation and its solution (1.7). If inequality (1.11) holds strictly then solution is

$$V=\frac{\left[c\exp\left\{\frac{q\sqrt{1-2F/qc}}{m}(t-t_0)\right\}\left(V_0-c-c\sqrt{1-2F/qc}\right)\left(\sqrt{1-2F/qc}-1\right)\right]}{\left[V_0-c+c\sqrt{1-2F/qc}-\exp\left\{\frac{q\sqrt{1-2F/qc}}{m}(t-t_0)\right\}\left(V_0-c-c\sqrt{1-2F/qc}\right)\right]}+$$

$$+\frac{\left(\sqrt{1-2F/qc}+1\right)\left(V_0-c+c\sqrt{1-2F/qc}\right)}{\left[V_0-c+c\sqrt{1-2F/qc}-\exp\left\{\frac{q\sqrt{1-2F/qc}}{m}(t-t_0)\right\}\left(V_0-c-c\sqrt{1-2F/qc}\right)\right]} \tag{2.1}$$

If $V_0=0$, $t_0=0$ then (2.1) becomes a little simpler

$$V=\frac{2F\left[\exp\left\{\frac{q\sqrt{1-2F/qc}}{m}t\right\}-1\right]}{q\left[\left(-1+\sqrt{1-2F/qc}\right)+\exp\left\{\frac{q\sqrt{1-2F/qc}}{m}t\right\}\left(1+\sqrt{1-2F/qc}\right)\right]} \tag{2.2}$$

Force magnitude F is arbitrary here; it depends on our choice, but we consider it constant during integration process. When F is acquired, a speed $U=2F/q$ is also acquired. Eq. (2.2) implies that the velocity **V** gained by charge q is proportional to the velocity **U** defined by the force **F** acting on q. When $t=0$, the fraction made of square brackets in the numerator and denominator reduces to

$$\frac{e^0-1}{2\sqrt{1-2F/qc}}$$

i.e. it is null. When t grows, this fraction grows as well, and comes to unity, after which the electron preserves steady velocity **U** defined by the applied force **F**. The time interval from the start of motion up to achieving this velocity **U** is the time of the electron's accelerated movement.

It was assumed earlier that

$$1-2F/qc>0 \tag{2.3}$$

or equivalently, that

$$U=2F/q<c \tag{2.4}$$

(The problem of dimensions is considered in [2].)

But one can see that correlation (2.2) is also reasonable when inequality (2.3) becomes an equality; *i.e.*, when

$$2F/q = U = c \tag{2.5}$$

Light velocity is apparently achieved in this case:

$$V = c \tag{2.6}$$

This fact is coordinated to (1.10). It is necessary to emphasize that in order to achieve a certain velocity, just force, is essential and not force impulse. Multiplir depending on t in (2.2) grows quickly with growing t, and converges to a certain constant depending on $\mathbf{U}$. Therefore long action with constant force rather quickly leads the (2.2) solution to expression (1.10). The velocity becomes constant. Therefore big impulse enlarges the track covered, but does not guarantee velocity enlargement. This is also true with respect to energy spent for electron's acceleration: its gradient is essential, but not produced work.

Let us investigate some examples that explain the result we found. From [1] we take the electron's charge $q = 7.3\times 10^{-10}\text{kg/s}$, which implies $q/m = \omega = 8.1\times 10^{20}\text{Hz}$, *i.e.* q/m is the angular velocity of the mass creating the electron.

Example 1

Let $1 - 2F/qc = 1/4$, *i.e.* $F = 3/8\, qc = 0{,}082$ Newton per electron. Then

$$V = \frac{4\times 0.041\times 10^{10}(e^{\omega t} - 1)}{7.3(3e^{\omega t} - 1)} \approx 1.5\times 10^{8}\,\text{m/s}$$

Example 2

Let $1 - 2F/qc = 0.0137$, *i.e.* $F = 0.108$ Newton per electron. Then $V \approx 2.06\times 10^{8}\,\text{m/s}$.

Example 3

Let $1 - 2F/qc = 10^{-6}$,*i.e.* $V = 0.10948$ Newton per electron. Then $V = 2.99\times 10^{8}\,\text{m/s}$.

When $F = 0.1095$ Newton per electron, it achieves light velocity.

The force root $\sqrt{2F/qe - 1}$ in the proposed theory is in a certain sense analogous to relativistic root $\sqrt{1-\beta^2}$. But it differs in at least one essential aspect: its equality to zero does not lead to physically absurd infinities. A design change in the force root just changes the character of the motion, as we see below.

Case $1 - 2F/qc < 0$. Superluminal Movement

In this case Eq. (1.10) does not posses real solutions, *i.e.* there does not exist a conserving force for any initial velocity $\mathbf{V}_0$. Nevertheless, Eq. (1.7) has a solution. Its left hand part is

$$\int_{V_0}^{V} \frac{dV}{a + bV + pV^2} = \frac{2}{\sqrt{4ap - b^2}}\, arctg \frac{2pV + b}{\sqrt{4ap - b^2}}\Bigg|_{V_0}^{V} \tag{3.1}$$

One gets after corresponding transformations

$$\frac{\sqrt{2F/qc - 1}\left(V - V_0\right)}{c^2\left(2F/qc - 1\right) + \left(V - c\right)\cdot\left(V_0 - c\right)} = tg\left(\frac{q\sqrt{2F/qc - 1}}{2m}\left(t - t_0\right)\right) \tag{3.2}$$

Hence

$$V = \frac{\left[2Fc/q - cV_0\right] tg\left(\frac{q\sqrt{2F/qc - 1}}{2m}\left(t - t_0\right)\right) + cV_0\sqrt{2F/qc - 1}}{\left[c\sqrt{2F/qc - 1} - \left(V_0 - c\right) tg\left(\frac{q\sqrt{2F/qc - 1}}{2m}\left(t - t_0\right)\right)\right]} \tag{3.3}$$

If $V_0 = 0$, $t_0 = 0$, then

$$V = \frac{2F\, tg\left(\frac{q\sqrt{2F/qc - 1}}{2m}t\right)}{q\left[\sqrt{2F/qc - 1} + tg\left(\frac{q\sqrt{2F/qc - 1}}{2m}t\right)\right]} \tag{3.4}$$

Superluminal speed V oscillates about a mean speed $U = 2F/q$.

If $V_0 = c$, $t_0 = 0$ then

$$V = c + c\sqrt{2F/qc - 1}\; tg\left(\frac{q\sqrt{2F/qc - 1}}{2m}t\right) \tag{3.5}$$

If force root is equal to zero, *i.e.* $U = c$ then (3.5) implies $V = c$. This means that formulas for sublight and superlight velocities are coordinated when light barrier is overcome.

Mathematically, the tangent function has a break of the second type. Physically, the break points correspond to moments of radiation. This means that 'near luminal' movement looks as follows: the electron rushes by the light barrier, irradiates, and falls down to subluminal speed. Its mean speed in such a process is close to light speed from below, or even from above, as takes place in the Cherenkov effect.

Thus originates the idea of impossibility to overcome light barrier. One can propose a hydrodynamic interpretation for the fact. Light speed is a critical speed for ether flow around the electron. When this speed is achieved, laminar flow changes to turbulent flow. The vortices created are sensed by us as radiation. Let us use this concept to find some ether characteristics. Let as take as characteristic dimension electron its radius which was evaluated in [1] as $r_0 = 3.8\times 10^{-13}\text{m}$. The Reynold's number is

$$R_e = cr_0/\nu \tag{3.6}$$

where ν is kinematics' velocity of the ether for electron. Turbulent flow begins when $R_e \approx 2000$. Thus

$$\nu = 5.7\times 10^{-8}\text{m}^2/\text{s} \tag{3.7}$$

It was shown in [6] that ether density $\varepsilon_0 = 1.87 \times 10^8$ kg/m³. Thus viscosity

$$\eta = \nu\varepsilon_0 = 10.66\text{kg/ms} \qquad (3.8)$$

Let us stress that everything said above refers to electric charge. Ether flows by electrically neutral bodies as an ideal liquid (or close to it). Apparently Euler's paradox is valid for electrically neutral bodies: ether does not resist its steady movement. Hence Newton's first law turns to be valid (or almost valid). Well known experiments showing mass dependudance on speed "perhaps will force us to refuse of this" assumption. But this is an object of special consideration.

Let us return to formula [1.12]. It implies that if $\mathbf{V}_0$ achieves $2c$ in laminar region electrons begin moving without resistance. The problem is that turbulent flow begins when speed achieves $c = 1/\sqrt{\varepsilon\mu}$ where ε is ether density and μ is ether compressibility in the medium. The problem can be solved if light velocity in the medium is low and current is created in another medium with higher light velocity. In this case electrons of usual current in the last medium can achieve $2c$ velocity in the first one. Apparently just this effect is observed in very well known cases of superconductivity. Temperature decreasing decreases light velocity in circuit and already speed of electrons in usual current achieves $2c$ velocity in circuit.

Summary of Argument

A model is proposed in which an electron moves in a medium, ether, which is assumed to fill all space. The ether is not given any qualities *a priori*; we find out the qualities by the action of the ether on a moving object. Ether does not act on a massive body moving steadily in it (Newton's first law). This means for us that this medium acts on a mass as an ideal liquid (Euler paradox). Only accelerated movement needs force.

But an electron experiences a certain drag already even when moving steadily. In accord with the author's concept in [1], this is because electron is a rotation of a certain mass. Mathematically this means that electron is a derivative of this mass with respect to time. Or stated in another way: a steadily moving electron is an accelerated mass. And ether resists such acceleration. Conditions when ether does not resist electron movement are found.

The received differential equation has solution which describes not only sublight but also superlight movement.

References

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[5] J.G. Klyushin, "Generalized Dynamics About Forces Acting on a Charge Moving in Capacitor and Solenoid", The international Congress-2000: Fundamental problems of Natural Sciences and Engineering (Proceedings, St. Petersburg, 2000).