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7/42

Dear Professor Fitzgerald,

Your very kind letter was received, and I thank you very much for your willingness to criticise my paper, and is it passes satisfactorily, as I think it will, to place it where it will be seen.

With regard to the interaction between ether and matter, I think you will find that all right. In my desire not to bore you with a too diffuse description I omitted everything except the skeleton of my theory. As you will note when I send the paper, we have the electrical phenomena in the pure ether, where the drop of potential per unit length is the velocity; the surface density of an electricity charge is the momentum per unit volume; the magnetic force is the torque per unit volume; the specific inductive capacity is the density, and the permeability is the elasticity ; the conductivity being the frictionality. This you will see is practically one of the theories treated of by Heavyside, (Elect. Mag. Theory, vol. 1, page 254, always remembering that Heavyside is using a special notation dealing with unit chunks of space.) Lord Kelvin has a theory too, on somewhat the same lines, but not elaborated so far. Heavyside only applies his theory to pure ether phenomena, ~~and~~ except the one case of a conduction current. The difficulties he mentions on page 253, (14th. line from the bottom,) ~~and~~ are, the ones ~~the~~

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Put briefly, the matter comes to this. In all previous theories, things were indeterminate, because in none of the usual theories is there and relation ~~shown~~ necessary in the theory, between matter and electricity. This is shown by the duplex form in which all these theories appear, i.e. to every theory there is its mate, in which the electric and magnetic quantities are interchanged.

What I have done is to nail the correct theory by noticing that the magnetic reluctivity, (reciprocal of the ferric permeability, ~~or to be exact~~ is the reciprocal of 4π times the susceptibility,) which is defined ~~a~~ by the equation

ferric reluctivity $= H/(B-H)$

is a linear function of the magnetic force, H.

I.e. — ferric reluctivity $= a + bH$.

This being true, as found by exhaustive experiment, no other theory is possible except that which makes μ have the dimensions of a reciprocal of an elasticity and k have the dimensions of a density. where μ is the magnetic permeability and k is the specific inductive capacity.

If for instance, magnetic energy were kinetic, then there would be no escape from the capacity of a condenser being inversely proportional to a linear function of the drop of ~~pot~~ electrical potential per unit of distance between the plates. This is not true, therefore magnetic energy ~~must~~ cannot be kinetic. But the ferric reluctivity being a linear function of the magnetising force, or difference of mag. pot. per unit of length, the electric energy must be kinetic. and the other laws discovered by Weber, Coulomb and Faraday give us three more equations (given in my previous letter,) which necessitate magnetic energy as energy of strain. No other theory is possible. and only modifications in detail can exist. These details are largely cleared up by the answer to the following question. "Under what conditions, if we were given a body in a dark room, could we identify a given end of it, if it were taken from us and then handed back again?" "Either by its dimensions, or by its being in motion, or by its fitting onto someting else which is in motion, as a screw on a nut, (we could not identify either end of a stationary nut, or screw,) unless it fitted onto a revolving screw or nut, or by its being of a double constitution. Now we can identify either end of a magnet, or ~~a charged body~~ of a body charged electrically, in a dark room, ~~we also know~~ without referring to their dimensions, by holding them between the poles of a magnet or the knobs of an induction machine. We are here independant of of the dimensions of the ~~ch~~ polarized bodies. We also know that there is no motion in a magnetised body, on account of the above four dimensional equations. We are hence reduced to the ~~fact~~ result that the other matter must be doubly constituted. because we couldnt identify the ends of both magnetised and electrically charged bodiesin the dark unless it were.

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be, i.e. that specific inductive capacity is a density, permeability is the reciprocal of an elasticity. that the dimensions of quantity of electricity are M/T and of quantity of magnetism L/. No future work can possibly change these, the only question is whether the theory I have taken, i.e. that electric energy is kinetic and magnetic is energy of st strain, is correct in its details.

I was much interested in what you say of your discussion with Lord Kelvin. If you will not consider it presumptious of me I would say that I think you are quite right about our having no use for a condensational wave. As to whether matter has charges connected with it under all conditions of state, I believe it has, in fact I believe I was the first to suggest that. (Laws and nature of cohesion, 1889) though Helmholtz had previously, as I since found, suggested it in connection with chemical phenomena. (i.e. th that an apparently uncharged atom had really 2 charges on it, of opposite sign.) I fancied I got over, in that way, all the difficulties about the relation of force and distance in the theories of elasticity. Certainly the results I got agreed with experiment, but possibly you may not agree with me. Everything works together very nicely, however, in fact Larmor has shown that, though I do not know that he was acquainted with my previous work. With many thanks for your kindness, I remain,

Sincerely yours,

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that come up when we go from a medium of one specific inductive capacity to a medium of another sp. ind. cap. Take a condenser with the medium between the plates consisting of one sheet of glass and one of paraffin. Since the pot. drop per unit length is the velocity, he does not see how, in passing from the glass to the paraffin, we can have one velocity in the glass and an immediate increase of velocity on passing from the glass into the paraffin. But this is the beauty of the thing, and just where the relation between electricity and matter comes in, for we can see, that to keep the energy right we must have the momentum per unit volume constant in the two media, and ~~in order~~ since the specific inductive capacity in the density, and the density in the two media is different, the velocity must change in order to keep the momentum constant.

The other place where matter touches the other in in the conduction current, where the conductivity is the frictionality, and the current square resistance loss is proportional to the velocity ×force of friction, which itself is proportional to the first power of the velocity of the ~~current~~ quantity of electricity. This agrees prettily with my empirical formula, given in the paper on Conduction.

I do not know when I shall get the paper finished, possibly not for a month, as I am very busy with a lot of engineering matters, mining plants, locomotives, etc., but I will send it to you as soon as possible. You are of course, quite welcome to work on the relations I have given you, which must be correct, no matter what the details ma