

Paignton Devon
25.12.93

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My dear Fitzgerald, In a loose manner Faraday may be referred to as the author of the elec. law., but that is too vague in math's papers. Now Maxwell has elaborated ^{the} theory, & if he had stated it quite clearly & fully, there would be something quite definite to refer to. My point about what we ~~do~~ understand by his theory is that it needs some revision to make it a distinct self contained theory (right or wrong). to wh. one can refer without ambiguity. I make it essentially a theory of one medium; the first & most important part. Now if you would call "any reasonable modification of the fundamental idea, Maxwell's theory" you open the door to all sorts of variants, & then, in writing papers, you will always have to explain what you mean. I have been struck in reading one or two German papers with the need of some understanding on this matter, for there was a great elaboration of preliminary equations, ^(which had to be waded through) without any statement that it was merely Maxwell's theory with such or such a special point elaborated or added to it; now the latter only is what the Author is concerned with as an Author or elaborator.

I know next to nothing about the "impossible

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"Colwell" of Germans following Hertz. I did think Hertz was very good. He took substantially the same view about the meaning of Maxwell's theory as I do, that it is a primary theory of one medium; at least, I believe if you asked him, he would agree to that. I would not discourage mathematical speculation on that basis; it is well to have all sides developed, and out of failures comes success, sometimes. Besides, I am by no means sure that Electromagnetic theory on the basis of one medium may not be successfully used even in cases where it cannot be true, by a suitable interpretation of the relation of added terms to the original of the primary theory. And perhaps this may be a practical way.

Your remarks on 4π reveal a difference of opinion on a fundamental point. You say we have not yet so far as to define a rational system of units. I must regard this as quite wrong. The 4π question is wholly distinct from the question, what is the meaning of E in $\frac{1}{2}CE^2$ (which is Known) or of H in $\frac{1}{2}\mu H^2$ (also known, i.e. both known ⁱⁿ volume). Even if you have discovered a mechanical explanation I think it true, you don't alter the case about 4π. It is a fundamental question independent of mechanical explanations. My

rational μ and C are identical with
 Maxwell's μ and K (^{in passing I may say that}
 object to a capital letter, the mere look of the formulae show it
 should be small; and I use K for Conductance
 and K for Conductivity), whatever they may
be in a mechanical theory. Find out
 what μ and C are. It makes no difference
 in the ^{derived} national units, though it gives a mechanical meaning
 to them if we choose to take $\mu = 1$ or make μ itself a primary
 fundamental quantity (like length, etc.)
 in the so called "electromagnetic system".
 Very well, it is just the same in the
 rational system of units. Consequently
 if you can agree with me about the
 actual wrongness of the present system
~~you can~~ ⁱⁿ the way the strength of sources
 is reckoned (which had its origin in
 the gravity law, I presume). I think you
 are logically bound to agree to the rest of
 the above. In short, if you did know
 everything, it would still be expressed
 rationally if you chose to have $CE^2/8\pi$
 etc. etc. etc. in your formulae. I can't
 even conceive the possibility of the question

arising whether they are or are not, 4π lines of
 force from a unit source? It is now, as you
 say, a matter of convention or definition. I
 add, as it always will be. But the present
 system is founded upon an irrational convention.
 This is right and wrong even in conventions. Just
 as an illustration, think of the absurdity of
 two physical properties, permeability to induction
 and susceptibility to magnetisation, both considered
 cubically or rectangularly, as regards the same
 unit cells for example, being connected with
 one another through the 4π ; say

$$\mu = 1 + 4\pi K$$

conductance of a body
 according to their

permeability

etc.

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There is something laughable in the idea of it,
 when you think what it is supposed to mean,
 i.e. as regards susceptibility and permeability,
 (both numeries essentially). You can explain it
 away, of course, and in doing so ^{you have to} confer that
 the system (present one) is absurd. There is
 nothing that I am more certain about than
 the absurdity of the present conventions, and
 I am quite certain that ~~they~~ ^{the irrational system} will become
 recognised to be a scientific disgrace. Though
 I be in a minority of 1 only, & the minority
 itself, I shall not hesitate to expose the
 scientific disgrace. It is actually necessary to

do so merely to explain the ^{real} meaning of the common formulae! In terms of rational units ab initio, the question would never arise. But I had no idea of running over about 4 π when I started. Yet there is more to say. Is 4 π a millionaire, as you say? ~~What~~

~~What~~ Has a scientific question to do with Baal? Let Baal have a whack on the head, then! There is an inconsistency even as regards Baal. There is a greater vested interest than that of the makers of shams of nonnumerical origin. I refer to the makers of yard measures, pint pots, scales, spring balances, surveying rods & chains, & heaps of other things, with centuries of popular usage to support them. And yet people actually believe it is possible to reform all that, as other countries have done. And Lord Kelvin is I believe, one of those enthusiasts. What a little affair the electrical standards is, in comparison! Is it possible that Lord K. can be a reformer as regards the English weights & measures, and not as regards the electrical standards? Now

I really believe that it was the wise action of the B.A. Com. in adopting the metric system that rendered the reform of the British units possible, in this ultra conservative

country, by its educational influence, and that in consequence thereof, the British reform is not so very distant. If the B.A. Com. had adopted the yard, pound etc. I doubt if it would have been within even distant sight, ^{thus a telescope.} I think the B.A. Com. ought to complete its work. It will be a funny state of affairs if it doesn't.

I am not so sure that your reminder that H0 is different from 4 π as regards a question of fact is so strong as it looks at first. Two atoms or one? Why two? Simply because it harmonized the electrical laws, which previously had puzzling anomalies & inconsistencies requiring cocking. It is very similar about the 4 π . My rational system puts the theory of tubes of force straight on its legs; it waddled before, & had to be supported by 4 π crutches. It simplifies and harmonizes all electrical relations, so that they tell their tale straight, & require no cocking. Atoms are human inventions, to facilitate the study of chemistry, and tubes of force are human inventions in like manner, though I would not push the Likeness too far.

Your enquiry about effective mass of a charged atom. I make it

$$m + \frac{2}{3} \frac{4\pi q^2}{a}$$

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(in irrational units for your convenience)

where m is the steady mass, and the rest what is apparently added by the magnetic momentum, supposed quasi-rigidly connected with the real momentum, when the charge is q , the radius a (spherical atom) and the speed through the ether is a very small fraction of v of light.

[Z. P. v. 2, p. 505, equation (2)]. μ

is the inductivity outside the atom; if the "e.m.g.-units" are used, then μ is the numeric permeability, so I suppose it would be 1 in atomic calculations in general. (N.B. it is not a convention in

my rational system that the permeability equals 1 in other ^{written e.m.g. or e.stat. units are} The inductivity is used unknown, but then it is virtually made a fundamental quantity).

But as regard the application, that seems to me rather vague. It is, I believe, considered that atomic charges are facts, mainly on account of electrolysis. But there may be other ways of accounting for the facts. But supposing them realities, we have to balance them in the gross, because they give rise to no external displacement

(i.e. residual, like a charged body). I suppose, therefore, that interference with Kepler's Laws would be virtually nonexistent by mutual cancellations. For we can't apply those laws to single atoms. I mean, experimentally, they apply to matter in the gross, and we do not even know whether they apply to one atom uncharged. But I know very little about atomic science.

I have not ^{tried to} drive a dynamo by talking to a microphone, principally because I have not got a dynamo. But I will think over your suggestion & see if I can make anything out of it.

With the seasonal wishes

Yours sincerely
Oliver Heaviside

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