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Action at a Distance

In explaining the effects of an electric charge in motion by reference to Fig 7, it has been tacitly assumed that there is action at a distance in the aether. Coulomb's law of electrostatic interaction between electric charge has been the basis of the whole argument even though a case has been declared favouring energy action as more fundamental than the force effect. Force arises when motion permits energy to develop what it is that we experience as a force.

Now, there are those who think that field theory excuses us from the need to worry about action at a distance. Also, there are advocates of mechanical aether theory who just cannot accept such a thing as action at a distance. The energy argument developed in this work and as used by reference to Fig. 2 may or may not give a satisfactory alternative to these sceptics. It seems that the orthodox scientific community accepts 'field theory' as the convenient alternative, without quite understanding the physical reality of the 'field'. Action at a distance still bothers the realist element in scientific thought. It is authoritatively dismissed by abstraction in a paper by Hoyle and Narlikar* with the words:

> The success of field theory has overshadowed the action at a distance theories, although, ironically, we nowadays need have no difficulty with the problem that seemed so worrying to Newton and his followers, namely the mystery of how particles manage to act on each other when they are at a distance apart. We now know that particle couplings are propagated along null geodesics—i.e. at no distance in the four dimensional sense. Strictly, the phrase 'action at a distance' should be changed to 'action at no distance'.

* 'A new theory of gravitation', *Proc. Roy. Soc., A,* Vol. 282, pp. 191–207, 1964.

This is peculiar thinking. It seems that Einstein's theory can be used to transform words as well as frames of reference. We are simply concerned with the question of how two electric charges relatively at rest act upon one another, somehow exerting their mutual effects across the space separating them, and we are told they are both at the same point in space–time. Two electric charges can be separated by a distance in a three-dimensional world and since we are concerned with Coulomb's law, a law derived from experiment in an assumedly three-dimensional reference frame, we had better restrict ourselves to this real world if we expect to achieve anything meaningful. Are two spaced electric charges constantly subjected to the mutual interaction force? Are they in a state of jitter due to pulsations in the actions and delays in propagating their interactions? These questions may offend the physicist who lives by abstraction. The offence, however, may well arise because it is irritating to have a problem and not to have any clear answers. It is easier to argue that all that matters is what can be measured. If one cannot make measurements to determine the truth it probably will not matter to our physics how abstract our thoughts, as long as they link at least somewhere with the reality of observation. Is it not better to acknowledge our difficulties and let the students of physics wrestle with them, as problems of real physics, rather than as abstract riddles purportedly connected with the true nature of things?

Stedman,* writing recently on 'Broken Symmetry' in *Science Progress*, gave perspective to the philosophical implications of abstract physical principles when he referred to a reported conversation involving Heisenberg:

> Someone asked Heisenberg in the discussion time: 'Why then did God create the world with asymmetry in it?' Heisenberg's reply: 'Only nothingness is absolutely symmetrical, and there would be no point in creating that.'

Stedman then went on to write:

> Perhaps the rambling account above is reminiscent of the endless debates of the schoolmen of the Middle Ages, on such questions as:

* G. E. Stedman, *Science Progress*, Vol. 58, pp. 507–23, 1970.

'When a fish swims, which moves first, the water or the fish?' If such apparently futile questions form the warp and woof of modern physical theory, it would appear that we are not much better off than the schoolmen.

A question may seem futile if we do not know the answer, but it is better to keep in mind such futile questions than to offer to others futile answers. In many matters in physics we have progressed remarkably little from the state of knowledge in the Middle Ages.

When we contemplate the problem of action at a distance perhaps we are in a poor state of mind. It is the present author's contention that there is a real aether medium. Such is the subject of this book. But this belief has arisen from the discovery that much of the accepted physics of electromagnetic theory is inconsistent and that the weaknesses can be remedied by involving the electrified aether medium. Coulomb's law has been the foundation of all the author's analysis. It is the most fundamental physical law relied upon by the author in building the theory published in his earlier works.* Certainty has come from the quantitative derivation of the universal physical constants. These are the features which give the theory its real meaning. The universal constants of physics are somehow determined by Nature; they are determined quantitatively, and, of course, qualitatively. However, it is easier to contrive qualitative arguments purporting to explain what is observed than it is to couple with a qualitative picture a derivation of the observed numerical features. Quantitative support does exist for the simple qualitative physics given in this work. The form of the aether under discussion can be analysed in depth by applying classical electrical theory with some corrections. By discovering that if an electron does not radiate its energy when accelerated it must possess the property of inertia, the aether, as an energy containing medium in its own right, has come in evidence and also mass properties have become a consequence of the electrical properties of the aether.

The author has therefore been content to brush aside the

* *The Theory of Gravitation*, 1st edition 1960, 2nd edition 1966 and *Physics without Einstein*, 1969.

concepts of those advocating an aether based on mechanical foundations and, of course, the author's ideas, along with any favouring an aether, are set aside by those scientists of our time who are happy with life as a matrix of mathematical equations in a void.

One staunch advocate of aether theory is Oscar N. R. Potier, who has questioned the lack of definition of energy in the author's work, pointing out that energy is really force times distance. He writes:*

> You suggest that gravitation is a magnetic phenomenon. This means that action at a distance and tractive, tensile, or attractive forces are accepted, against the teaching of the sacrosanct laws of mechanics—contiguity and push or compression as the only possible forms of reality where physical forces are concerned.

Potier's own theory† is based upon an ever-accelerating universal expansion by which all elements of matter are forced further and further apart by forces transmitted by a space substance forming the aether. The inertial restraint appears as a gravitational attraction if this accelerated expansion is not appreciated. This idea can be disputed on quantitative grounds but it does, in principle, show how an unwillingness to give in to the doctrines of established physics and accept the inexplicable action at a distance forces can provoke new thoughts about the fundamental mechanics of our universe.

Now, it is not particularly worthwhile to argue that energy is force acting through a distance when, in fact, force may be a measure of energy change when whatever is associated with the energy undergoes a change of spatial configuration, that is, change of distance. Given energy and distance we need have little difficulty with the concept of force. Given force and distance we can understand energy, but energy can be something existing in its own right, whereas force implies something else. Energy is a scalar quantity whereas force is a vector. Energy is the more basic parameter. The example from the human frame

* Private communication dated Lisbon, January 9, 1971.

† Oscar N. R. Potier, 'The Fundamental Mechanism', paper read before Portuguese-Spanish Congress for the Progress of Science, Seville, November 23, 1960.

is that a lifeless unenergized body can exert no force because it can expend no energy. An electric car battery needs energy before it can be applied to develop a force. So it may be in Nature, at the really fundamental level. Energy is a primary quantity and force a secondary effect. Therefore, it is not to be expected that we can ever fathom the very nature of energy.

The question we can approach is the problem of electric charge. Energy and space (distance) imply force and we need not invoke mass from these parameters, as did Newton. Instead, given energy and space, can we develop the notion of electric charge and from that then come to understand Coulomb's law and the problems of action at a distance. The author can explain mass from the electric nature of the aether, but the author may still be taught that the aether can yield an even more fundamental truth, possibly exposing the very nature of electricity. It is important to keep an open mind in these matters.

Let us, for the moment, return to Hoyle and Narlikar's 'action at no distance' theory. Their paper is entitled 'A new theory of gravitation' and concerns Hoyle's ideas of signals from the future. The subject is essentially the problem of the accelerated electron already treated by reference to Dirac's abstract ideas on electrons. The Schott energy referred to on page 97, as requiring a mechanical aether to apply the necessary forces, appears to be invoked when Hoyle and Narlikar write:

> An accelerated charge in an otherwise empty space experiences no electromagnetic force, whereas a damping force is actually observed.

It is not clear from this paper how this damping force has been 'observed'. Then, referring to Wheeler and Feynman, Hoyle and Narlikar write:

> They pointed out that the particles we actually observe to radiate are not in an otherwise empty world, so the theoretical result that such particles should not radiate is not necessarily a contradiction with experience.

The paper then talked about a 'static homogeneous universe of charged particles' which produces a reaction equal to half the usual retarded solution due to accelerated charge minus half the advanced solution. Not only do we need an aether, but we need

the inevitable signals from the future to reconcile the theoretical problems of energy radiation by electron acceleration. By assuming that an electron can radiate its energy scientists have given themselves a problem which they overcome by assuming that the aether sends energy to the electron anticipating its future movements. The human body is an assembly of electric charge and, on similar lines of thought, we must argue that the aether already contains the data governing our future movements, as if our destiny is ordained by the spiritual control of the aether substance. However much this may conform with religious conviction, it seems so much easier, scientifically speaking, to recognize that an electron will not radiate its energy. We must turn our physics around to satisfy this fundamental observation. The aether exists. This is beyond dispute. How far beyond dispute has been the question at issue since Einstein changed our frame of reference. However, the future does not exist until it happens, at least to those of us who understand what we mean by the word 'simultaneous'.

In Chapter 11 it was implied that the great thinkers in the classical period in physics had missed the fact that an accelerated electron derives its inertia because it does not radiate its energy. They did, however, not miss an important part of this fact, that is that an accelerated electron need not radiate its energy. Rather, they deliberately chose to ignore this possibility when they had the message clearly before them.

Professor G. H. Livens, Fellow of Jesus College, Cambridge, writing in the second edition of his book *The Theory of Electricity*, published by Cambridge University Press in 1926, presented this message quite forcibly. It is appropriate to quote from his work at some length. After deriving Poynting's formula for energy transfer, he writes:

> This is Poynting's result and this vector is usually called after him. It is however necessary to emphasize the fact that it represents the flux of energy only on the hypothesis that the kinetic energy is distributed in the medium with a density $\int_0^B H \, dB$ per unit volume; and even then it is uncertain to an additive vector quantity which integrates out when taken all over the surface f. However, following usual practice in physics, it is best to adhere to the simplest hypothesis. The actual

phenomena strongly suggest that the flux of energy is correctly represented by this vector and the addition of anything else is merely a gratuitous complication which is not, after all, necessary. There is however no definite and precise reason why we should take the matter this way; we might have adopted some other scheme. The only other one of any importance is obtained by performing the first integration by parts in some other way. We found that. . . . This is the general form of a result which has received very influential support in some quarters and there is something to be said for it. . . . In any case we cannot definitely say that either form is wrong, and the particular form of theory is entirely a matter of preference and not proof. The chief point to be noticed is that we get different distributions of magnetic energy according to the assumptions we make; the differences are, it is true, unimportant in the ordinary statical and dynamical aspects of the theory so far examined, but cases will be examined where the two distributions are of fundamentally different types. In some types of fields, for example, the densities of the magnetic energy on the two theories are equal in magnitude but opposite in sign.

The above appears between pages 242 and 244 of Livens' book. Written, as it was, in the heyday of the quantum theory, when more and more evidence was being discovered of energy transfer by discrete quantum processes, it is surprising that the popular preference did not switch to reject Poynting's ideas and accept the alternative outlined by Livens. Probably, however, the minds of the time were too busy with the new ideas in wave mechanics to be bothered repairing some of the classical theory. Professor Livens reverted to the problem on page 313 of his book writing 'On the flux of energy in radiation fields':

According to the usual conceptions of physical science, when energy travels by radiation the direction of the flux is along the ray, so that the flux vector gives not only the direction but also the intensity of the ray (the intensity of a ray being measured by the energy that passes along it per unit of time). In ordinary propagation in isotropic media the direction of the beam is perpendicular to the wave front, because the electric and magnetic vectors are both in this surface. The energy in this case travels along the beam normally to the wave surfaces. In crystalline media however it is the electric displacement vector that is in the wave front and the electric force is not coincident with the displacement so that the energy flux vector is no longer normal to the wave front. The direction of the ray, that is the path of the energy, is then oblique to the wave front surfaces, but in any case

its direction at any point is the same as that of the energy flux vector at that point.

In entering into a more detailed analysis of these phenomena the first difficulty encountered is the ambiguity in the definition of the flux vector. The usual procedure is to base the whole discussion on Poynting's form of the theory, which appears to provide the simplest view of the phenomena, and to ignore the possibility of alternatives. We must not however forget that our view-point may be coloured by a long use of the particular form of the theory as the sole possibility so that its apparent suitability may be at least misleading. It is therefore essential that we bear in mind that Poynting's theory is not the only one which is consistent with the rest of the electromagnetic scheme and we shall therefore follow the usual discussion along the lines laid down by Poynting by a brief review of at least one simple alternative.

After Livens has given the analysis using Poynting's theory he then writes:

The whole of this discussion has been based on Poynting's theory of the processes involved. If we turn to the single alternative theory suggested in paragraph 229 where the radiation vector appears not as the vector product of the force vectors but as the product of the complete vector current by the scalar potential . . . we shall find a remarkably different aspect of the whole of the processes.

He then shows energy transfer perpendicular to the direction of propagation of wave radiation and says:

Of course in a theory where there is to be no transfer of the energy, the whole conception of energy at a point must be different. That this is so in our present case is immediately obvious. According to the general discussion the appropriate formula for the kinetic energy density is . . . that is the kinetic energy now has the same value but the opposite sign to that usually employed in Poynting's theory, so that the total energy is on the modified theory simply the excess of the electric potential energy over the magnetic kinetic energy on the older interpretation. In the case of no absorption these are equal and the present theory does not associate energy at all with the radiation, so that no question of its transference arises. In the case of absorption it will be seen that the new theory identifies as the total energy in the field just that part of the energy which on Poynting's theory is not transferred.

Livens next considers the Hertzian vibrator and goes on:

Thus whereas on Poynting's theory the energy supplied to the field

at the vibrator is transferred outwards and radiated away, on the new form of the theory the energy, now however differently interpreted, is stored up in the field surrounding the vibrator and counted there in the kinetic energy. . . . We know without ambiguity the difference of the energies . . ., the Lagrangian function, which is of necessity correct, as it leads to equations which have been proved by experiment to represent the motions of observable electrons. But beyond this the rest is pure conjecture.

Livens says 'beyond this and the rest is pure conjecture', yet we have had half a century of pure conjecture thrust upon us because we favoured the wrong alternative. Professor Livens puts the case for non-radiation of energy and the case for negative field energy. The present author, unaware of Livens' work,* was later to develop these same notions on independent lines and to follow their stimulus in understanding magnetic phenomena.

We may now revert to the problem of action at a distance and the nature of electric charge. Let us proceed, attempting a simple logical approach. Three dimensions are needed to define the parameters of physics. We may choose dimensions which are observed as variable quantities or we may opt to base our physics on dimensions which match the basic physical constants. In the latter case we would need to explain then why a particular quantity could occur as a constant. Therefore, logically, we will choose as primary dimensions quantities which are variable, or rather arbitrary, in the scheme of Nature. Thus electric charge seems to be a fixed quantum and cannot be considered as primary. Hence, we can hope to explain it in terms of more fundamental concepts. Nature somehow keeps the electron charge invariable. It is a determined quantity and is not arbitrarily fixed by some quirk of Nature. Variables we can use as primary dimensions are energy, time and distance. A universe can be constructed in one's imagination which permits the distance between its elements to be set arbitrarily. If the elements move to relate to time then time can be set arbitrarily as well. Also, energy does not come in Nature as a fixed quantum. Even a photon is frequency-dependent. Hence energy, space (or dis-

* I am indebted to Mr. David Eagles for drawing Livens' work to my attention in November 1970.

tance) and time are appropriate primary dimension quantities.

Time, distance and energy may have units set by Nature but all can change. More important is that electric charge can come in positive and negative forms. Now what does this really mean? We only have positive and negative as notional concepts; something we interpret by mathematics in comparing two quantities. In terms of time, distance and energy we cannot conceive negative time or negative space. Negative energy is no better than negative substance. A negative energy component is possible if our measure is relative to a positive reference and negative magnetic field energy as contemplated in Chapter 12 only implies an aether permeated with energy and depleted to become energy in some other form. Negative energy is an impossible notion in any fundamental frame of reference. Nevertheless we can combine space and time to develop opposites. We can conceive opposites which arbitrarily become positive or negative in the choice of direction of movement or rotation of an element of energy.

It follows from this that the logical approach to explaining Coulomb's law and the charge it connects is to try to seek out something which offers motion of energy in a plenum. Vortex theory is the likely candidate. Such speculations will not be pursued here save for a cautionary remark. Vortex theory often presumes the existence of particle forms in a fluid medium and accounts for their interaction in terms of the vortices ever present when they move. This assumption will not advance us to a better solution than was found when vortex theories went out of fashion at the beginning of the twentieth century. The particle form itself must be part of the same fluid form. It could be a cluster of vortex filaments in an all-pervading incompressible fluid medium.

Given a particle concept in terms of motion and an energy substance, mass can be developed from the dimensional relationship between energy and velocity. Perhaps then if the particle form is nothing more than a vortex system it may move to conserve itself and thus display inertial properties and its mass in keeping with the author's theory. To be reasonably content with such an approach Coulomb's law would need to be

explained and, consequent upon this, magnetic effects. This was the fundamental object of many of the old aether theories which claimed success in their time. Whittaker* has provided an excellent account of such theories. Also, however, vortex theory is still very much alive in some minds. See, for example, the work of Wilhelm M. Bauer.†

It may seem to the reader that to speak of vortex theories of a fluid aether is to set the clock back a century. It is out of tune with the world of the modern physicist. Yet the eventual truths about the aether will not change with time and the truths of the past will not either. The physicists of the last century may not have had the experimental data we possess today, but equally they could focus their undistracted attention on to the fundamental philosophical implications of the subject. Their conclusions may not be conclusive, but their lines of enquiry deserve respect and should not be rejected without some caution. After all, they did possess some experimental facts which the modern physicist still cannot explain.

It is gratifying to see a report of a lecture in June 1971 presented by Professor Wheeler at the Cambridge Institute of Theoretical Astronomy:‡

> His new discipline describes reality without recourse to either mass or charge. Whereas Einstein described a universe where the curvature of space–time was a product of real masses for which Einstein could not account theoretically, Wheeler's universe accounts for all phenomena without the need to postulate any real mass at all. This is a revolutionary improvement on Einstein. Its full implications are only beginning to be realised. In superspace, Wheeler contends, 'pregeometry' constructs material out of non-material. This plenteous nothing (not to be confused with antiquated theories of an aether) contains entities of dimensions far too small for direct observation. However, on a scale of the order of 10^{-33} cm the universe is a fabulously rich sea of events, eddies, vortices, and foam.

Let us, therefore, revive vortex theory of the substance permeating empty space, but let us be at pains to avoid anything antiquated. A modern aether is what is needed.

* *History of the Theories of Aether and Electricity, The Classical Theories*, Nelson, London, 1951.

† *Mechanik Elektromagnetischer Vorgänge*, 1965.

‡ *New Scientist and Science Journal*, July 29, 1971, p. 242.