# 9

# *Boundaries of Relativity*

In the concluding pages of the previous chapter we escaped losing ourselves in the abstract world we entered earlier. We arrived at a conclusion about the law of electrodynamic interaction between electric charge in motion without even defining what we meant by motion. It was a natural result of being satisfied that our theory fitted what we saw. Electrons in motion can be measured. Their velocity is determined from a knowledge of their mass, their charge and their centrifugal behaviour when deflected by an electric or magnetic field. Velocity is measured relative to the earth frame, the frame from which we make most of measurements in physics. It is the frame we have in mind when we speak of motion. Philosophically we may wonder if the same laws of physics would apply if measurements were made on the surface of the moon. It seems quite probable because test apparatus sent to the moon appears to function there much as it does on earth. Therefore, philosophically, we can accept the Principle of Relativity or we can say that both the moon and the earth have their own aether moving with them and all physics are the same relative to this aether medium. Motion of electric charge really means motion relative to a frame of reference in the aether, if our interest centres on magnetic effects. This is hypothesis, but it is a good working hypothesis and it suits the ideas presented in Chapter 4. Nevertheless, we must admit that other ideas can have closer claim on the truth, until there is conclusive evidence determining which is right. So we will be tolerant of Relativity and explore that subject further now.

Let us stay with the problem of the force between two electric charges in motion. The reader may glance at the reference works available to him to find the textbook formulae for the interaction force. But, search as he may, he will not find anything to prove that a formula has been verified by experiment. Therefore, the reader must keep a critical eye on the way the formulae are derived.

It will be found that there is an empirical formula for the force on an electric charge in motion in an electric and in a magnetic field. It is known as the Lorentz force equation. Being empirical, the equation has to be believed, having due regard for the restrictions imposed by the experimental techniques used. For example, we must remember that the magnetic field on which the empirical facts are established is not produced by a single electron but by electric currents in closed circuits or by whatever it is that generates magnetic field inside a ferromagnet.

Writing about this empirical equation, Dingle* said:

> This is not deducible from the general equations of the field according to classical theory, and has therefore to be ranked as an additional postulate. The modifications introduced by Relativity, however, remove the necessity for this, since, when the proper transformation equations are used, the force appears as a consequence of the change of the co-ordinate system.

Now, this is a very powerful statement. To say that an empirical equation of classical physics cannot be deduced from classical field theory is itself a challenging remark, and it certainly is not true today. The force on an electric charge due to an electric field can be derived from classical field energy analysis. The force on the charge due to a magnetic field can also be derived by classical techniques, as was shown at the end of the previous chapter, provided, of course, we know the origins of the magnetic field or assume that it is produced by a circuital current. But, for Dingle to say that the force on an electron can be understood in the mere transformation of a co-ordinate system is unduly provocative. We should be in rebellion at this blatant suggestion that magnetism is an electric field viewed from a different reference system. But how can we rebel without weapons? Words and philosophy are no help against an established doctrine. Well, we do have weapons. We have our experimental facts, and we can disprove what Dingle says. First, note that if we can develop a magnetic field merely by transforming a

* *The Special Theory of Relativity*, H. Dingle, Methuen, 1950, p. 79.

co-ordinate system, we have contrived to do what Nature herself cannot do. We have produced a field which is not characteristically dependent upon a source. We have assumed that all magnetic fields are generated, not by a discrete electric charge, but by some system defined by co-ordinates. We have invoked some kind of infinite electric fluid. It is, of course, the electric charge continuum introduced by Maxwell to explain his displacement currents. Maxwell's equations are the basis of the transformations used in Relativity to derive a magnetic field from an electric field and vice versa. But, of course, if you do this, you are no longer talking of magnetic fields produced by electrons or discrete charges in a system under analysis. You are assuming that all magnetic fields are in effect the same as those developed by a uniform electric charge in the aether medium. Well, they are not the same. To assume that they are the same will merely lead to a result which is correct only for those situations where the magnetic field is developed by a current which is a closed circuit one. The infinite current filaments of the notional charge continuum invoked by transforming Maxwell's equations are, mathematically, closed circuits.

Evidently, Relativity denies the possibility that a magnetic field could develop a force on an electric charge along the direction in which the charge is moving. Lorentz's formula says the magnetic force has to act at right angles to the motion. Yet, if the magnetic effect is produced by a charge following in line behind the first charge, there is no magnetic field along points in this line but there is an electrodynamic force between the charges. Many authors have provided experimental evidence of these forces. They appear as anomalous cathode reaction forces where electric discharges are under study. Furthermore, our understanding of the energy in a magnetic field should tell us that the interaction energy between two electric current elements when aligned is dependent upon their separation distance. If they comprise two electrons moving forward in the same line, they will have an electrodynamic force set against their mutual repulsive force. Also, if gravitation is an electrodynamic force action, as Einstein tried to show without success, we would expect gravitation to act between particles even though they are moving along a common line. All sense points to this result. Therefore, we must, indeed, be careful before accepting the Lorentz formulation. Since Relativity leads to the formula without any reservation, it shows the ineffectiveness of the relativistic method.

Still, there is more criticism to come. If we follow Dingle, we should take the basic force on electric charge as the product of the strength of the charge and the electric field intensity. The transformations come after we have made this assumption. What experiment has ever shown that the force on a unit charge is simply the electric field intensity? The answer is 'none', so we have another questionable assumption on which relativistic argument is founded. The electric field intensity is actually defined as the measure of the force exerted on unit charge. The field is the imaginary connection between two interacting electric charges, themselves defined in terms of force. The definition of force in terms of field-charge interaction must seem valid. It is used so extensively in electrical theory. Yet it is not universally valid. There are hidden implications in the fundamental notions of classical field theory which will not permit the use of this simple basic fact without some reservation. Curiously, the reservations only seem to impact Relativity, because classical theory tends to start out with charge as the source of electric fields, whereas Relativity pulls field out from nowhere by the magic of abstract transformations of reference frames.

The reader who is interested should trace through classical theory to find how the ideas of a field and field energy are reconciled with the forces acting between electric charges. He will find that inevitably the charges involved have to be specified and that inevitably there are boundary conditions to take into account. This is seen immediately if we consider a uniform electric field. An electric particle in this field will have its own symmetrical field and the interaction field energy cannot be calculated without specifying the boundaries. If the boundaries are put at infinity, then the interaction energy is infinite. The force is determined by the change of energy when the particle is displaced. Hence, it is measured by the difference between two infinities, an indeterminate quantity. On the other hand, by symmetry, we see that the particle will not know where it is relative to the field and so cannot be under any force. Now, our problem has come about because we have invented a field. If we specify where the charge producing the field is located, then we have no problem. We can even develop a uniform electric field between two capacitor plates and work through the field energy analysis to find that there is the expected force on a particle of charge located between the plates. In fact, the usual formula for the force only applies because the boundary conditions permit the realization of an actual system of charge. The charge location or equivalent boundary conditions have to be capable of specification.

With Relativity, an electric field can be produced from a magnetic field by transforming co-ordinates. What this means in terms of redistribution of electric charge and charges in boundary conditions defies interpretation. Possibly a planar charge distribution suddenly appears as if we all live between the remote parallel plates of an imaginary capacitor. Possibly this problem is not important. Relativity may only be a convenient symbology by which to relate physical concepts. But it should not then be used to explain the nature of physical phenomena. Boundary conditions cannot be ignored in applying Relativity.

For those readers who remain sceptical and think Einstein's theory inviolate, it is appropriate to note that Einstein himself alerted us to the boundary difficulties. Einstein died in 1955 but, in an appendix he added to the fifth edition of his *Meaning of Relativity* (1956 with preface dated December 1954), he wrote in his concluding remarks at page 164:

> A field theory is not yet completely determined by the system of field equations. . . . Should one postulate boundary conditions? . . . Without such a postulate, the theory is much too vague. In my opinion the answer to the question is that postulation of boundary conditions is indispensable.

He goes on to give support for this argument and thereby points to the need for further research.

It must be accepted that the relativistic derivation of the Lorentz equation is on an inadequate foundation. The empirical law of electrodynamics, as developed by the author with logical theoretical foundations, seems to be the correct law for dealing with interaction between isolated charges in motion. The reader is, therefore, warned to be cautious about believing the theoretical ramifications thrust at him in the textbooks on Relativity. So much of physics depends upon the interaction of electric charge that you just have no way of founding physical theories of Nature if you set out with the wrong law of electrodynamics.

Care is needed because physicists are human and they make mistakes. Everyone makes mistakes, and it is particularly easy in theoretical research. The researcher is setting off on a journey in the dark along an uncharted road. If he gets lost, he has no one to put him back on the right track until someone else comes down the same road, goes back, finds a better road and bothers to come back again to collect the lost soul. All this takes time, centuries of time, and with so many people rushing around, all lost at once, the chances of sorting things out are reducing rather than increasing. But there is an added difficulty. There are those who go along the right road and come back to invite others to follow. Yet they will not follow because someone already out of reach has assured everyone that he has explored that same path and found nothing. There is imperfect recollection of what he really reported but it still daunts the willingness to believe the more favourable reports. Such is the world of the physicist unless he is a recognized explorer of the jungle and can take a large following with him wherever he may go.

I am, incidentally, thinking of certain characters and experiences of my own in putting together the above observations. The man now out of reach is the Reverend Samuel Earnshaw (1805–1888). He left behind him an interesting proposition, generally referred to as Earnshaw's theorem. According to this theorem, an isolated electric charge cannot remain in stable equilibrium under the action of electrostatic forces only. I found my papers being rejected because my discoveries were in conflict with Earnshaw's law. Hence, the question, 'Who was Earnshaw?' Well, this same question had troubled someone else. W. T. Scott had undertaken the task of tracing Earnshaw's work to find the source of this great theorem. He describes his difficulties and his eventual success in a paper published in the *American Journal of Physics* in 1959 under the title 'Who Was Earnshaw?'*

He found a treatise published by Cambridge University Press in 1879 which made reference to the reading of a paper before the Cambridge Philosophical Society in 1839, and later published in their *Transactions* at pp. 97–114 in volume 7 of 1842. Earnshaw's paper was entitled: 'On the Nature of the Molecular Forces which regulate the Constitution of the Luminiferous Ether'. Earnshaw proved that the aether could not constitute electric charges retained in relatively stable configuration, if the forces acting between them are of the usual inverse square form, obeying Coulomb's law. For stability, the law of interaction force between the mutually attracted elements has to differ from that between mutually repelled elements. An inverse square law of gravitation will not hold a particle system stable against electrostatic forces of repulsion also according to the inverse square law. He concluded:

> It is therefore certain that the medium in which luminiferous waves are transmitted to our eyes is not constituted of such particles (acted on by purely inverse-square forces). The coincidence of numerical results, derived from a medium of such particles, with experiment, only shows that numerical results are no certain test of a theory, when limited to a few cases only.

This is quoted to show that over a century ago the basic problems of the aether were being studied with vigour. Conclusions were reached and their effects have echoed along the corridors of science and influenced the development of modern physics. We find that Jeans† has taken up Earnshaw's theorem by arguing that it denies the possibility of a stable union of discrete charge such as protons and electrons to form atomic nuclei. This is interesting, particularly because it is a modern quest to seek the discrete constituent charges deemed to form such nuclei. The search for quarks seems to be an effort mounted in ignorance or defiance of the great work of the Reverend Samuel Earnshaw.

* Volume 27, p. 418.

† Sir James Jeans, *The Mathematical Theory of Electricity and Magnetism*, Cambridge University Press, 5th edition, p. 168.

Now, I wish to explain where the physicist has gone wrong in applying Earnshaw's theorem. Firstly, Earnshaw himself was interested in an aether composed of particles of charge. The inverse square law of force was, logically, his only force relation. He proved that a system of particles could not be stable. Yet stability was a desirable aether property. But then he should have decided that the aether was not exclusively composed of particles. The aether we envisaged in Chapter 4 is a uniform charge continuum which is positive permeated by a system of identical electric charged particles, all negative. The positive charge is dispersed like a gas or fluid and, using the inverse square law, the mutual effects between this positive charge and the negative particles develops a restoring force on each such negative particle proportional to its displacement from a neutral position of stability in the continuum. Therefore, if the negative particles all move harmoniously about their respective neutral positions, we do have a stable system configured to explain the numerical values of the universal physical constants. Centrifugal force is in balance with the restoring force. The cycle time of the particle orbit is constant independent of disturbance, because the system is effectively a linear oscillator. Earnshaw's theorem is not violated because we have force relationships present which vary linearly with separation distance. We have a dynamic aether, but a stable one.

The basis of Earnshaw's theorem seems to be an earlier theorem according to Gauss, and the use of some ideas embodied in what is termed Poisson's equation. Essentially, the argument is that we imagine an isolated electric charge held in stability at a point where we know no charge resides. Then we say that the slightest displacement would be resisted because the potential gradient would be directed away from this point and this means that the electric field has to be directed towards the point. But, since stability implies resistance to movement in any direction, the field acting on the charge has to converge on this point from all directions. This it can only do if there is an external charge at the point itself, which is impossible because that is where our supposedly stable charge is located. Hence the theorem about instability.

The basis of the theorem is that the charge is isolated in free space. If the charge is surrounded by a sea of other charge, then the theorem fails. This has also been noticed by Scott, the man who traced Earnshaw's work. In a book dated 1966 he writes:*

> In a region of continuous charge distribution, a maximum or minimum could exist, but a continuous distribution is an idealization. We have to consider each electron or proton as an isolated charge, so that pure electrostatic equilibrium is impossible.

We live in an age of abstraction but not one of idealization! Why should not the very space substance which permeates us and holds us together be an idealization? The aether should be as near to the ideal substance as our imagination can ever take us. Earnshaw's theorem tells us that if pure electrostatic equilibrium is possible, then space must comprise a plenum of electric charge. Earnshaw's theorem also tells us that if ever we find that an atomic nucleus is a simple stable aggregation of electric charges, then space must comprise a plenum of electric charge and we must believe the real aether exists. We cannot wish away our very existence because of erroneous interpretation of mathematical results. Earnshaw's work did not destroy the aether. It provided another means for recognizing this great medium.

The physicist has tried to build his physics upon the interaction of electric charge but he got himself muddled when he drifted into mathematical arguments without following each stage carefully by physics. The physics can become muddled too if the physicist does not step back regularly to think what he is trying to do. For example, he expected that when the electron finally allowed us to measure its properties it would have an electric charge and a certain mass. Hopefully, all electrons would be the same. If they were not the same then, provided they could be grouped together in some logical order, they would have been given names in some kind of electron family. When success came, the satisfaction centred on the fact that the charge and mass of the electron could be measured and the degree of accuracy attained by the experiments. There should

* W. T. Scott, *The Physics of Electricity and Magnetism*, Wiley, p. 43.

have been satisfaction in greater measure at the discovery that, in fact, the electron was universally the same. This equality of all electrons is itself a physical phenomenon warranting explanation. Electrons can be created and annihilated, coming from and going into the void of space, absorbing or leaving mere energy in this exchange process. They come into being or die in company with the positron. They share their roles equally in this great vanishing trick which Nature performs to tantalize us. But why are they all the same, whether they are those performing in a laboratory in England or those performing in the United States? The simple answer is that there must be something shared by the environment in all the laboratories. This 'something' must be uniform in order that the parameters of the electrons created at different localities should be uniform. The origin of the electron must be a medium which is electrical in character and no amount of abstract thinking can avoid this conclusion. Relativity does not have the power to cross these boundaries either. The language of the aether is not Relativity. It is the physics of the electron, the properties of electric charge, which can reveal the secrets of the aether medium.

We will, therefore, move closer to the problems of charge, mass and energy of the electron. We will ask ourselves why, if all electrons are alike, they contrive to stay alike when our theories tell us that they are radiating their energy all the time they are accelerated. How can they do this when we know they travel through superconductive metals without using any energy at all? Has the phenomenon of the apparently infinite conductivity of certain materials at certain low temperatures been explained by abstraction too? Or can we be naïve enough to suggest that it is atoms which radiate energy, not electrons, so that only when the thermal conditions of the atom allow it to be triggered into radiation by electron impact will we see any generation of the heat which manifests the property of electrical resistance? Let us proceed with the suspicious thought that electrons do not radiate energy and that those who say that mathematics prove otherwise have jumped to the wrong conclusions.