on their high lands than is New Zealand. The lofty mountain ranges which traverse both islands, and the excessively broken nature of the land over large areas, together with an average high rainfall, lead to the presence of innumerable streams, and offer ideal conditions for denudation; hence the mountains would, if not forest clad, be a constant source of danger to the farm lands on which the prosperity of the country so largely depends. The original covering of forest, which —except where soil or climatic conditions were adverse—occupied the whole land, and extended to a height of between 3000 and 4500 ft., has now been enormously reduced, and there has been much unnecessary destruction extending to the steep slopes of hills, and even to the upper altitudinal limits of the forest; hence the headwaters of many streams are no longer provided with tree cover, and the general watersheds of the larger rivers have lost their original efficient protection. The commission strongly recommend, therefore, that these mountain forests should be strictly preserved against further interference, and that every factor which is destructive to the forest undergrowth should be rigorously repressed—this will entail the restriction of deer and other destructive animals to limited enclosures.

The importance of scenic reserves, which includes several distinct classes of reserve, is fully realised by the enlightened Government of the Dominion, which is annually adding large areas to its already long list of such reserves, and is in this respect setting a splendid example to older countries. In this connection it may be noted that of the seventeen hundred species of trees, shrubs, herbs, ferns, and fern allies included in the New Zealand flora, more than three-fourths are found nowhere else in the world, and that this vegetation is, except where disturbed by human occupation, of a truly primitive type. In 1903 Sir Joseph Ward, then Minister in charge of the Tourist Department, introduced the Scenery Preservation Act, which provided for a Royal Commission to report upon all areas possessing scenic or historic interest, or on which there were thermal springs, and submit recommendations for the acquisition of such as seemed desirable, whether Crown, freehold, or native. After this commission had worked for two years, it was terminated by an amending Act substituting a small permanent advisory board of Government officials, the Scenery Preservation Board, which investigates and reports from time to time on all areas worthy of inspection, and by a further Act passed in 1910 the whole of the reserves were made sanctuaries for the flora and fauna, so that no firearm may be discharged on a scenic reserve, nor may any bird or game be killed thereon. The reserves now set aside for scenic purposes number 518, and there are also five national parks consisting for the greater part of extremely steep land, much of which is at a high altitude and more or less barren, while three islands have been set apart for the protection of New Zealand birds. The Forestry Commission recommend the constitution of a further series of scenic reserves.

The report for 1912 of the Scenery Preservation Board shows that during the year ended March 31, 1912, there were acquired no fewer than ninety-six additional reserves, with an aggregate area of 94,000 acres, at a total cost to the Government of less than 6000*l.*, the latter figure including as the two heaviest items the expenditure involved in survey and the compensation paid for private and native lands acquired. F. C.

THE PRINCIPLE OF RELATIVITY.
I.

PERHAPS the most comprehensive generalisation in physical science since Newton's enunciation of the law of gravitation is the conception of an all-pervading æther, the medium of transmission of light and of electrical and magnetic disturbances. From the time when Maxwell adopted this conception from Faraday and established the identity of light and electric waves, the "æther" has become a fundamental element of our thought about the physical world.

But it has been a standing puzzle for many years to find out whether the æther is pushed and carried along by the earth as it moves or whether it is of such a nature that it can pass through solid matter so that we may think of it as undisturbed by the motion of bodies through it. Without going over the history of the controversy it may be stated that by the beginning of this century it had been almost universally accepted that the simplest way to think of the æther was to suppose it to be stagnant and immovable. Thus there seemed a possible solution to an older puzzle, that of the failure of mechanics to specify a unique and universal frame of reference for the motion of bodies. The æther promised to supply one. But, unfortunately, when experiments were devised to determine the velocity of the earth relative to the æther, they one and all failed. Thus came into being the principle of relativity, which is simply the *hypothesis* that *we never shall know or be able to define what is the exact velocity of the earth or any other body relative to the aether.*

Of course, this must not be taken as a dogmatic assertion or a philosophic doctrine, but as a working hypothesis, the consequences of which are to be examined and verified at every possible point by comparison with experiment. But the boldness of the hypothesis requires a little justification. It arose, as a matter of fact, directly out of the theory built up by Lorentz and Larmor on the basis of a stagnant æther for the purpose of explaining the failure of the experiments that have been referred to. This theory was so comprehensive that it distinctly predicted the failure of all conceivable experiments designed for the purpose of identifying the æther as a frame relative to which the velocities of bodies might be measured; just as the comprehensive dynamical theory of Newton, though at the outset it postulates a standard of absolute position, involves the consequence that this standard cannot be a unique one. When, for example, Lord Rayleigh conceived and carried out in 1902 an experiment in which he sought to find evidence of double refraction in a plate of glass owing to its motion through the æther, Sir Joseph Larmor gave it as his opinion that the negative result was to be expected on theoretical grounds.

It may be taken indeed as proved that in so far as matter is electrically constituted, the form of the equations which embody the theory is such that effects due to the motion of bodies as a whole through the æther must always be concealed.

But is matter of purely electromagnetic constitution? Are existing theories able to give a complete account of those phenomena which have actually been experimentally investigated?

The classical experiment of Michelson and Morley may be taken as an example on which to test these questions. It is generally admitted that this experiment shows that we cannot detect a difference in the velocity of light relative to the earth in two directions at right angles one of which may be thought of as parallel and the other perpendicular to the motion of the earth through the æther. Such a difference must exist if light is thought of as being propagated with the same velocity in all directions relative to the æther.

The only suggestion that could be made to reconcile the failure of the search for this difference with the theory of a stationary æther was that of FitzGerald, that the motion of the apparatus through the æther so modifies its internal constitution that it automatically contracts to an extent which exactly neutralises the effect which would otherwise be observed. It was in the effort to give a reason for this contraction that the theory that has been referred to was developed. But whether we take the presentation given by Larmor or Lorentz we find that the general equations of the electromagnetic field have to be supplemented at some point by a hypothesis as to the nature of the electrons which are the elementary constituents of matter, in order to make the scheme sufficient to determine the way in which they will move. Now the length of a body, thought of as constituted by electrons, depends upon the motions of those electrons. If we are to think of any piece of matter whatever as contracting according to FitzGerald's hypothesis, we are bound to think of the paths of the electrons within the body as being modified in some corresponding way. Thus the hypotheses that may be adopted as to the nature of the electron are not arbitrary, but must be such as will lead to the contraction hypothesis as a consequence.

Similarly, if we consider the experiment of Rayleigh referred to above, the refracting properties of glass are conceived to be due to the light waves falling upon electrons which have inertia and which have to be moved by the electrical forces produced by the light. If we were to assume that the electrons have a definite mass in the Newtonian sense, then Rayleigh's expectation of a double refraction when the glass is moving would be justified. Lorentz is able, however, by assuming *among other things* that the electron is a spherical nucleus which itself is subject to the FitzGerald contraction, to extend his argument to cover the null result of this experiment. But the special assumptions which he makes were all made with an eye towards the result, namely, the failure of experiment to give a positive evidence of motion through the æther. They were hypotheses *ad hoc*, and to that extent they were really, though the name had not been invented, applications of the principle of relativity. It cannot be shown from the form of the general equations of the electromagnetic field alone that null effects are to be expected, for the experimental results most certainly extend into regions where these equations are insufficient; they do not cover, for instance, the whole theory of refraction, of conduction of electricity, or of the exterior configuration of a given body.

It is for this reason that the hypothesis that the *fact of motion relative to the aether must be for ever concealed*, becomes of importance as a general and independent principle. It becomes a criterion and a guide, for example, as to the form that is to be chosen for the constitutive relations which connect the electric force and displacement, the magnetic force and induction, and the current in moving bodies. It leads us to the conclusion that the Newtonian conception of a constant mass needs some revision if the hypothesis is true, and at this point comes into touch with the experiments on the variation of the apparent inertia of a negative electron with its velocity, and in fact is here confirmed.

But although experiment suggested and has so far confirmed the validity of the hypothesis, yet two serious objections are raised against it. The first is that it conflicts with our simplest ideas as to the measurement of space and time, and the second is that it abolishes the æther as a unique and objective medium, the seat of all electrical activity. In a succeeding article an attempt will be made to indicate what position in regard to these two very important points the adoption of the hypothesis requires us to take.

E. CUNNINGHAM.

DR. J. REYNOLDS GREEN, F.R.S.

THE announcement of the death of Dr. Reynolds Green, on June 3, will have been received with unfeigned regret by all his scientific fellow-workers, whether botanists or physiologists. For those who, like myself, have known him throughout his career with a considerable degree of intimacy, regret amounts to a deep sense of personal loss. It is some consolation to me to have this opportunity of writing a few words in appreciation of him who was so closely associated with me first as pupil, then as collaborator, always as friend.

Joseph Reynolds Green came up to Cambridge in 1880 as a scholar of Trinity College, in which