

Attention has therefore been turned to other possible modifications of the theory. A very wide choice seems to be possible, so that the theory could be made to fit almost any form of the experimental spectrum in several different ways. This elasticity is perhaps an advantage, in that there is no immediate danger of our being forced to abandon the neutrino theory and therefore the conservation laws, but it destroys much of the heuristic value of the theory. For example, although the β -transmutations can be classified into two groups, corresponding to the two Sargent curves connecting the decay constant with the energy of the end point, it is not known how this

classification is connected with the change of nuclear spin in the transmutation.

In conclusion, the general impression given by this discussion was that although the neutrino theory is probably capable of explaining most of the features of the β -ray transmutation, it scarcely does so in the natural and unforced way which alone would reconcile the physicist to an unobservable particle. However, it remains a working hypothesis useful in directing attention to the points which still require experimental work, and in collating the data already obtained.

A. NUNN MAY.

Lightning

AN instructive paper on lightning was read on January 7 by B. L. Goodlet, of the Metropolitan-Vickers Electric Co., Ltd., to the Institution of Electrical Engineers. He discussed lightning first as a physical phenomenon and then gave the elementary theory of direct strokes to transmission circuits. He began by saying that although "Lightning" was the title of the Kelvin Lecture given seven years ago, yet the progress made during the last seven years is at least as great as that made during the previous seventy. He awarded due credit to the early pioneers, but modern research on the subject has been so intensive in high-tension laboratories, in the upper atmosphere and in connexion with the tens of thousands of miles of high-tension overhead wires now in continuous operation, that the modern research workers have large sources of experimental data from which they can test theories widely accepted in recent years.

The cumulo-nimbus cloud, or thundercloud, differs from the ordinary rain cloud in having greater vertical dimensions and in the existence of powerful upward air currents. Its formation is associated with convective instability of the atmosphere, the separation of the electric charge being effected by the resulting upward currents of air. Lightning strokes usually discharge negative electricity into the ground, and consist of a preliminary 'leader' stroke from cloud to earth followed by a powerful return stroke from earth to cloud. Schonland found by means of a Boys camera that each flash is initiated by a streamer which shoots rapidly downwards from the cloud towards the ground, but becomes extinguished before it has travelled more than a fraction of the total distance. About 50 microseconds later, a second streamer follows closely on the track of the first and elongates the channel a little farther. This goes on until an ionized channel is blazed all the way from cloud to earth. The rate of growth of the channel is of the order of 100 kilometres per second.

The maximum current at the ground end of a lightning flash is deduced from the intensity of the magnetic field produced in the vicinity of transmission towers and lightning conductors struck by lightning. About 24,000 magnetic detectors were distributed over the lines of various German electric power companies in 1934. The results showed that the most frequent value of the maximum stroke current lay between 30,000 and 40,000 amperes. Currents greater

than 100,000 amperes occur very rarely. In 97 per cent of the cases recorded, the cloud discharged negative electricity to the earth. Presumably therefore the base of the cloud must have been negative. Similar results have been obtained in the United States.

The question has often been discussed as to whether certain localities receive an abnormal proportion of lightning strokes. The evidence in favour of localization of lightning flashes comes mainly from the records of electricity undertakings. It has been found, for example, that a certain 80 km. line received 43 strokes, of which 26 fell on one section 6.3 km. in length. Investigation showed that this section of the line was traversed by underground springs. A study of available data has convinced the author that the existence of 'danger spots' struck more frequently for a given storm exposure is a fact.

Some interesting lightning problems occur in connexion with aircraft. Ten cases are known of British aeroplanes having been struck by lightning. In nine out of the ten cases, the wireless aerial was hanging down and was damaged. Moored kite balloons are particularly troubled by phenomena of this nature. When an aeroplane or an airship is flown through a thundercloud, the metal parts of the machine, unless bonded together, acquire very different potentials. Shocks are experienced by persons inside the aircraft when they touch and when they leave go of metal objects.

The earth currents caused by lightning can be a source of great danger. If a current of 50,000 amperes enters the soil at a point and spreads out uniformly in all directions, the voltage drop on the surface as we go away from the point may be very large even at some distance away from the point. The voltage between two points on the earth separated by the length of an animal's stride may be quite sufficient to pass a lethal current up one leg and down another.

The second part of the paper was more technical, being concerned mainly with direct strokes to transmission circuits. In this case rather more than half the direct strokes to a line fall on the conductors in the span between the towers. The final potential of an insulated conductor so struck is probably never less than 2 million volts, and may be sixteen times as great. The insulator impulse spark-over voltage of the most heavily insulated overhead line yet

constructed is of the order of $2\frac{1}{2}$ million volts. Wooden poles give additional insulation to earth, but cannot be relied on to withstand more than 100–150 kV. per foot. It seems highly probable, therefore, that practically every direct stroke to a live wire will produce some kind of flash-over.

Hence it is necessary to prevent direct strokes or to render flash-overs innocuous. The first can be done by an overhead earthed wire, which proves to be a reasonably effective interceptor; but in places where special protection is required, two earthed overhead wires should be used. In order to secure easy entrance for the current in dry soil, many modern lines are equipped with a 'counterpoise'. This consists of a length of bare cable buried in the ground and attached to the foot of the tower. Each circuit of the new Boulder Dam line in America is equipped with two parallel counterpoises, continuous from tower to tower.

The alternative to lightning-proof construction of the line is to ensure that lightning flash-overs on the line do not interrupt the supply. The best known method of doing this is to use a Petersen coil, which is in general use on the Continent but is less popular in Great Britain and the United States. Alternative methods were also mentioned. In the author's opinion, these methods will prove more popular than the overhead earthed wire, as they are much cheaper. Arc rupturing devices and lightning arrestors can be installed easily on existing unsatisfactory lines.

University Events

BIRMINGHAM.—Dr. Henry Pratt Newsholme, Medical Officer of Health for Birmingham since 1927, has been appointed to the chair of hygiene and public health in succession to the late Sir John Robertson.

CAMBRIDGE.—Prof. E. D. Adrian, Fellow of Trinity College, Foulerton professor of the Royal Society, has been elected as from October 1 to the professorship of physiology which will become vacant by the retirement of Sir Joseph Barcroft.

The subject for the Sedgwick Prize for the year 1940 is: "The Influence of the Idea of Evolution on some Branch of Geological Studies". The essays must be sent to the Registry on or before October 1, 1939.

The examiners consider that the following essays submitted by candidates for the Smith's Prizes and Rayleigh Prizes are of distinction: H. M. Cundy (Trinity College), "Motion in a Tetrahedral Field"; E. R. Love (Trinity College), "Riemann-Stieltjes Integrals"; H. R. Pitt (Peterhouse), "Tauberian Theorems". The Smith's Prizes have been awarded to E. R. Love and H. R. Pitt and a Rayleigh Prize to H. M. Cundy.

GLASGOW.—Prof. G. G. Henderson, regius professor of chemistry, has sent in his resignation, to take effect from October 1.

Dr. J. Bassil Rennie has been appointed whole-time lecturer in the practice of medicine.

SOUTHAMPTON.—Dr. N. K. Adam, research chemist in Imperial Chemical Industries, Ltd., has been appointed professor of chemistry in University College.

Science News a Century Ago

Birds of Paradise of the Arru Islands

At a meeting of the Royal Geographical Society held on March 13, 1837, a communication by W. S. Earl was read entitled "On the Key and Arru Islands". The Arru Islands, the author said, were about forty miles south-west of Papua, or New Guinea, and about a hundred miles to the north-east of Timor Laut. The Keys were a smaller group about thirty miles to the westward of the Arrus. The islands were small but closely grouped. Much commercial intercourse prevailed between the islands and the neighbouring coasts, the chief exports being tortoise-shell, bees-wax, ambergris, edible birds' nests and birds of paradise. The last were found in great numbers on the Arrus and the coasts of New Guinea. They were especially valuable, and from the numbers sent to Singapore appeared to be inexhaustible.

Valentyn, a Dutchman who wrote on the East in 1702, described seven varieties of these beautiful birds, while Le Vaillant, and later Guimard, gave descriptions of them. They were exported in great numbers to Arabia and Persia. Francois Valentyn or Valentijn, who was born in 1666 and died about 1725, was a protestant minister at Amboina, Banda and other places.

The Zoological Society

VARIOUS papers were read at the meeting of the Zoological Society held on March 14, 1837, one of them being by Darwin on the *Rhea Americana* and the newly discovered species, in which he described its mode of swimming, a fact unnoticed by earlier writers, but which he had witnessed in two instances. Their progress through the water was slow, very little of the body appearing above the surface, the necks being extended slightly forward. According to the Guachos, the males carried out incubation and not only hatched the eggs, but also attended the young until they were able to provide for themselves. Several females laid in one nest and the number of eggs deposited by each female during the season was from forty to fifty, or according to Azara, from sixty to seventy.

Physical Science in the University of Edinburgh

No one did more to further the study of physics in Scotland a century ago than J. D. Forbes, who instituted a complete working system of examining for degrees in arts in the University of Edinburgh by means of printed papers. His letters frequently contained references to his efforts to stimulate an interest in natural philosophy, and writing on March 15, 1837, to Airy, he said:

"I have been exceedingly busy, and not very well, which have been the causes of my silence. Among other occupations I have had to read five essays, which I have received in competition for a medal I proposed on the Undulatory Theory of Light, a new subject in Scotland, which I am delighted to find has stirred up our youth, and I have got some really respectable compositions. This is a proof to me that things are mending, and that exertion, private and personal, is not thrown away, even where public sympathy or support is not to be looked for.

"I have not abandoned my polarized heat, but have been much driven about this winter. I have got twelve thermometers sunk in different soils from three to twenty-six feet deep, to measure conduction."