mass-number and charge, its momentum, as deduced from its range, is found to equal that of the π -meson. The transformation may therefore be written:

The total release of energy is 41.5 MeV., a value which corresponds to a binding energy of the Λ^0 -particle to the other two nucleons of the excited triton equal to about 1.5 MeV.

The latest two events, which allow such a close analysis, appear finally to exclude the possibility that the phenomenon under discussion is to be explained in terms of a meson in an orbit around the nucleus. Such an explanation, in the case of a light meson (π), has already been eliminated by the observed emission of π^- -mesons from the disintegrating fragment; but the possibility of a heavy meson remained. In the last two events, however, there is a momentum balance among the charged secondary particles, and the total release of kinetic energy is about 40 MeV. If the disintegrations are attributed to the nuclear capture of a negative heavy meson, an energy of ~ 300 MeV. remains unaccounted for. The emission of a neutral particle, or particles, of high energy and momentum, would therefore have to be assumed. The observed momentum balance, so convincingly demonstrated in the event described by Bonetti *et al.*—together with the values of the binding energy of the Λ^0 -particle deduced on the basis of the alternative assumption—would then have to be regarded as fortuitous. Such a possibility is remote and can be rejected on the grounds of its extreme improbability. It appears, therefore, that the explanation in terms of a Λ^0 -particle is alone acceptable.

In view of the many laboratories now working on the subject, it seems certain that many further examples permitting a detailed analysis will soon be found. In time, it should be possible to determine the binding energies of the Λ^0 -particle in a variety of nuclear species. It has been pointed out by Cheston and Primakoff¹⁵ that a particularly interesting example, not hitherto observed, would be an excited deuteron:

It remains to be seen, however, whether the cohesion between a Λ^0 -particle and a single proton is strong enough to render such an assembly sufficiently stable to be observed.

It has been suggested in an earlier paragraph that it may be useful to describe the Λ^0 -particle as an excited nucleon, but it is already clear that the analogy is of limited validity. An excited hydrogen atom, to use the simplest example, consists of a proton and an electron in a state of higher energy than in the normal atom. The analogy might then suggest that the excited nucleon consists of a proton and an associated π -meson—that the Λ^0 is a composite particle. Such a view could not have been finally excluded while our knowledge was confined to the decay of the free Λ^0 -particles. Their relative stability as components of nuclei appears, however, to do so, for it is generally believed that, when captured by a nucleus, a π^- -meson interacts with its nucleons in a time short compared with 10^{-12} s., the disappearance of its rest-mass providing the energy of the disintegration. In the event described by Bonetti *et al.*, however, the nuclear fragment per-

sisted for longer than 2×10^{-10} s. before disintegrating. If the Λ^0 -particle consisted of a π^- -meson bound to a proton, it is difficult to see how the nuclear fragment could persist for such a long time on a nuclear time-scale. One would expect the bound π^- -meson to disintegrate the nucleus just as it does when captured from outside.

These considerations suggest that the Λ^0 -particle is an excited nucleon in a different sense from that suggested by familiar analogies. We are entering a new field where basically new concepts remain to be established; but it seems reasonable to conjecture that the nucleon is transformed into an excited nucleon as a result of changes in its internal constitution. If so, we are beginning to make a new penetration into what Maxwell called "the strange strata of the material world", a penetration into the world of the nucleon. It seems that matter is inexhaustible.

¹ Rochester and Butler, *Nature*, **160**, 855 (1947).

² See discussion, Bagnères Conf. Report (1953).

³ Barker, *Proc. Roy. Soc., A*, **221**, 328 (1954).

⁴ Thompson, Buskirk, Cohn, Karzmark and Rediker, Bagnères Conf. Report, p. 30 (1953).

⁵ See discussion, Bagnères Conf. Report (1953).

⁶ Fretter, Gregory, Johnston, Lagarrigue, Meyer, Muller and Peyrou, Bagnères Conf. Report, p. 26 (1953).

⁷ Fowler, Shutt, Thorndike and Whitmore, *Phys. Rev.* (in the press).

⁸ Friedlander, Keefe, Menon and Merlin, *Phil. Mag.* (in the press).

⁹ Danyasz and Pniewski, *Phil. Mag.*, **44**, 348 (1953).

¹⁰ Tidman, Davis, Herz and Tennant, *Phil. Mag.*, **44**, 350 (1953).

¹¹ Crussard and Morellet, *C.R. Acad. Sci., Paris*, **236**, 64 (1953).

¹² Freier, reported by Ney, Bagnères Conference, mimeographed report, p. 253 (1953).

¹³ Hill, Salant, Widgoff, Osborne, Pevener, Ritson, Crussard and Walker, *Bull. Amer. Phys. Soc.*, **29**, 60 (1954).

¹⁴ Bonetti, Levi, Setti, Panetti, Scarsi and Tomasini, *Nuovo Cimento*, **11**, 210 (1954); and private communication.

¹⁵ Cheston and Primakoff, *Phys. Rev.*, **92**, 1537 (1953).

OBITUARIES

Mr. Albert Campbell

ALBERT CAMPBELL, who died in Cambridge on February 6 at the age of ninety-one, will long be remembered as a pioneer in electrical science, especially in the fields of alternating current measurements and standards. He was one of the small band of men who under Glazebrook's leadership built up the National Physical Laboratory from almost nothing in 1901 to the research laboratory with a world-wide reputation that it had already become when Glazebrook retired in 1919. Campbell himself retired a little before Glazebrook, though not for the same reason; he had not reached the customary retiring age, but he realized that conditions were changing. To be a leading member of a research team in a government laboratory was a very different prospect from being a pioneer opening up new ground with freedom to move in whatever direction the spirit prompted. He retired and continued to work at home with home-made instruments, until, with a failing memory, he found himself no longer able to do scientific work.

The main body of Campbell's work was, of course, done at the National Physical Laboratory between 1901 and 1919, the most important single item being his primary standard of mutual inductance, constructed in 1907 and still the ultimate reference standard for nearly all the measurements of inductance, capacitance and related quantities made in

Great Britain. The work he did after his official retirement was, however, no less remarkable. It included his alternating-current potentiometer, which in some respects has not been surpassed, and also his best method for the absolute determination of the ohm. Has any other man three absolute methods to his credit? Naturally enough, with home-made instruments his accuracy was limited to barely 1 part in 10,000, but when elaborated at the National Physical Laboratory his method proved to rank with the best known to-day.

It is scarcely possible to indicate the scope of his work in a short note, but it is worth recalling that he devised the inductometer (his name for a continuously adjustable and direct-reading standard of inductance), the constant-inductance rheostat, the vibration galvanometer, the 'waveform sifter', one of the earliest electrical filters and the forerunner of the modern twin-T bridges. He set up the first standard wavemeter at the National Physical Laboratory, calibrated it absolutely by counting flashes in an oscillatory arc, and showed that the result agreed with values calculated from his measurements of inductance and capacitance. He also devised many alternating current bridges and methods for measuring all the magnetic properties of importance to the electrical industry.

Campbell's strong practical bent is the more remarkable in that at Cambridge he first read for the Mathematical Tripos, from which he went on to the natural sciences. In 1893 Alexander Russell persuaded him to go to Faraday House, London, where he remained until he joined Glazebrook. It was no doubt there that he acquired his insight into the scientific needs of the rapidly growing electrical industry, which he served so well in his own inimitable way later.

It is remarkable that, with one notable exception, none of the scientific honours that it is customary to shower on a man of his distinction seems to have come his way. He was a man of singular personal charm who showed the same interest in all his fellow-workers from the boy in the workshop to the clerk in the office and the most eminent scientific men of his time. One of these last once remarked of him that "Nobody had a kinder heart or a sharper tongue", from which it may be inferred that he was sometimes a thorn in the flesh of the authorities. In 1925 the Physical Society awarded him the Duddell Medal, and never was that honour more appropriately bestowed or more richly deserved.

L. HARTSHORN

Prof. D. S. Belyankin

WITH the death of Dmitry Stepanovich Belyankin, the U.S.S.R. has lost one of their most prominent petrologists. He was born on August 23, 1876, in Lomanikha, Vologda district, and died on June 20, 1953, in Moscow. Trained as a chemist under G. Tammann in the University of Youriev (Dorpat), he occupied successfully the posts of lecturer and of professor of mineralogy and petrology in the St. Petersburg Polytechnic Institute.

After his election as corresponding member of the Academy of Sciences in 1933, he became a member of the Petrographical Institute of the Academy, and moved to Moscow in 1935. In 1943 he was elected a full member of the Academy and after that he occupied a number of its more important posts, being

director of the Petrographical Institute and the Mineralogical Museum, editor of the Geological Section of the Bulletin and co-editor of the *Compte Rendu (Doklady)* of the Academy.

Belyankin published some three hundred and eighty papers and books (many of them written in collaboration), dealing with mineralogy, regional and descriptive petrology and technical petrology. He was particularly interested in feldspars, clay minerals and other silicates, and described and named several new species. He described various igneous rocks from Northern Russia, the Ural Mountains and the Caucasus, and wrote papers on magmatic differentiation and the nomenclature of igneous rocks. He was particularly interested in the development of technical petrology, of which he was the acknowledged master. He created the Russian school in this subject and he and his collaborators contributed a large number of works dealing with the study of refractories, ceramic products, glasses and metallurgical slags.

Belyankin combined an all-absorbing devotion to science with a friendly disposition towards all his pupils and friends, among whom I was proud to be included.

S. I. TOMKEIEFF

Prof. Giorgio Valle

ITALIAN science has suffered a grievous loss by the sudden death last December of G. Valle, head of the Department of Physics and director of the Righi Institute of the University of Bologna. Valle, who was born on December 15, 1888, at Trieste, read physics at the University of Vienna, where, having taken the degree of Dr.Phil., he worked as a demonstrator under E. Lecher until 1914. After the First World War, Valle taught for a short time at the Technical School at Terni and was later appointed professor at the Technical Institute at Bologna. In 1922 he moved to Asti, where he taught science at the Classical High School, at the same time lecturing to advanced students at the University of Turin. In 1932 he was appointed professor of experimental physics at the University of Ferrara, and in 1933 to the chair of physics at Parma, which he held until 1947. In that year he was elected to the chair of physics at Bologna, a post formerly held by A. Righi and Q. Majorana.

Valle, an assiduous worker, published more than seventy papers, mostly in *Nuovo Cimento*, the proceedings of the Accademia dei Lincei and of the Accademia di Torino, the *Wiener Berichte* and the *Physikalische Zeitschrift*. He made a series of notable contributions in the field of electric discharges, also in magnetism, acoustics, physical optics and meteorology. He was author or co-author of several text-books as well as of a volume of extracts from Righi's papers (see *Nature*, 167, 174; 1951) which he published in collaboration with G. C. Dalla Noca.

Valle was a man of great energy and vitality, and although during the past few years handicapped by the loss of his voice, he continued his scientific work until a month before his death. At the Righi Centenary Celebrations at Bologna in 1950, Valle, as an officer of the Italian Physical Society, was host to scientists from many countries, including Great Britain. A few months before his death he was at last able to gratify his wish to visit England, where he took part in the Oxford conference on ionization phenomena.

A. VON ENGEL