two liquid modifications, liquid helium I being stable above 2·3° and liquid helium II at lower temperatures; the density of the former is about 0·1 per cent higher than that of the latter.

Measurements of the specific heat of liquid helium were made by Dana and Onnes, who did not, however, publish the relatively high values obtained at temperatures near 2·3°, as these were not considered to be in accord with the other results. The apparent discordance is evidently due to the heat of transformation of helium I into helium II, which is calculated to be −0·13 cal. per gram. The heat of evaporation of helium appears to show a sudden variation, the value for helium II being the greater, while the surface tension of helium I exceeds that of helium II by about 3 per cent. It is remarkable that this transformation occurs at a temperature which corresponds, in the sense of the van der Waals' law of corresponding states, with the temperatures at which other substances melt.

Helium has, then, a triple point: liquid helium I—liquid helium II—vapour. Up to the present, such a point has been observed only for certain substances of complicated composition exhibiting a mesomorphic state (crystalline liquid), but further investigation is necessary before it can be ascertained if this is the case with helium. Fig. 3 is the characteristic diagram of the different states of helium, and shows the curve of saturated vapour pressure, the triple point, and the melting-point curve. Between liquid helium I and liquid helium

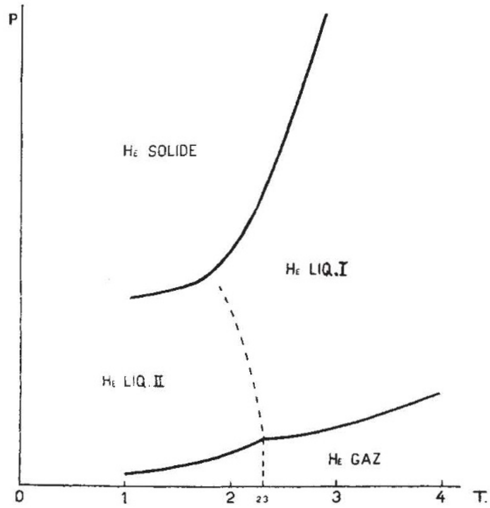

FIG. 3.

II there must be a transformation curve, but it is not yet known if this curve meets the melting-point curve, as shown in the diagram, or if it bends towards the axis of pressure.

Obituary.

PROF. G. H. BRYAN, F.R.S.

THE death of Prof. George Hartley Bryan on Oct. 13 removed one of the most interesting personalities among British mathematicians. His influence was felt in several directions, but it is in the mathematical theory of aeroplane flight that his work has made the greatest and most lasting impression.

Bryan was born at Cambridge on Mar. 1, 1864, the only child of Robert Purdie Bryan of Clare College. He lost his father at a very early age. His mother lived to a good old age, and Bryan always spoke of her with the greatest affection. He was brought up by his mother and his grandparents. He was the idol of the household, and being supposed to be delicate he was never allowed to go to school. Even when he went to Peterhouse as an undergraduate he was not given the opportunity of becoming self-reliant, for he still lived at home. The result of such an upbringing, in which discipline was totally absent, was a rather noticeable eccentricity, which did not, however, cover up a remarkable simplicity, honesty, and kindliness of character. Much of Bryan's early life was spent in Italy, France, and Germany. His excellent knowledge of the languages of these countries influenced both his scientific work and his literary style.

Bryan was fifth wrangler in the Mathematical Tripos of 1886 and second Smith's prizeman. He was a fellow of Peterhouse from 1889 until 1895. He succeeded the late Dr. G. B. Mathews as professor of pure and applied mathematics in the University College of North Wales, Bangor, in 1896, and held the chair until his retirement in 1926.

Hydrodynamical problems occupied Bryan's attention during the whole of his mathematical career. Inspired by the work of G. H. Darwin, he wrote important papers on the waves on, and the stability of, a rotating liquid spheroid, in 1888 and 1890. He soon became interested in the motion of solids through liquids, and in 1900 he produced a mathematical theory of the action of bilge keels in extinguishing the oscillations of a ship. This work was recognised by the award of the gold medal of the Institution of Naval Architects in 1901. He returned to the theory of discontinuous fluid motion as applied to a bent plate, in collaboration with Mr. R. Jones, in 1914, but meanwhile the fundamental work of Levi-Cività had introduced new methods for dealing with curved barriers, and the work of Lanchester, Joukowski, and Kutta was leading to the development of the powerful Prandtl theory. Later on Bryan wrote on the motion of an elastic fluid past a barrier.

The Cardiff meeting of the British Association in 1891 was the occasion of Bryan's important report on thermodynamics. He also wrote several independent researches based on kinetic theory, and when the "Encyklopädie der mathematischen Wissenschaften" was planned, Bryan was invited to contribute the section on thermodynamics. This appeared in 1903.

Bryan became interested in aviation very early, long before actual flight in an aeroplane had become possible. So early as 1901 he delivered a lecture at the Royal Institution in which he affirmed his belief in the possibility of artificial flight. Two years later he realised the necessity of making an attempt to ensure the longitudinal stability of flying machines, and in January 1904 he published, in collaboration with Mr. W. S. Williams, the epoch-making paper on the longitudinal stability of aerial gliders, in which he introduced the important conception of resistance derivatives, deduced the biquadratic equation which governs stability, and applied Routh's discriminant to the obtaining of the conditions of stability.

This mathematical theory gained the approval neither of mathematicians nor of those brave pioneers who demonstrated the practicability of aeroplane flight in the first decade of the present century. But Bryan persevered in his somewhat lonely work, and seven years later he published his "Stability in Aviation," a book that may now be reckoned as a classic in aeroplane theory. Meanwhile the Advisory Committee for Aeronautics had been established, and a department of aeronautics set up at the National Physical Laboratory. Bairstow developed practical methods for finding the numerical values of the resistance derivatives by means of the aerodynamic balance and wind channel, and very soon Bryan's theory of stability became an integral part of all aeroplane design. His triumph was complete when in 1914 he was awarded the gold medal of the (now) Royal Aeronautical Society. It is difficult to over-estimate the service thus rendered to aviation by the theoretical mathematician.

Bryan continued to interest himself in the rigid dynamics of aviation, and inspired the researches of many workers. From 1917 until 1920 he worked with the advantage of a special grant, which enabled him to set himself free from teaching duties for a part of the time. He spent several months at Bristol in collaboration with the present writer and Mr. D. Williams, elaborating the theory of canonical forms for dealing with the general motion of an aeroplane.

In addition to the honours already indicated, Bryan obtained the fellowship of the Royal Society in 1895, and was elected honorary fellow of Peterhouse in 1915. He served as president of the Mathematical Association and of the Institution of Aeronautical Engineers. He was an honorary member of the Calcutta Mathematical Society. Reference must also be made to the series of text-books written by Bryan on mathematics, mechanics, and astronomy for the University Tutorial Press.

Bryan married Miss Mabel Williams in 1906. Mrs. Bryan is now living at the villa near Bordighera in Italy, where Prof. and Mrs. Bryan made their home on Bryan's retirement in 1926. Their only daughter is now a student at Cambridge. A fortnight before his death, Bryan met many friends at the International Mathematical Congress at Bologna.

In the words of an old friend of Prof. Bryan, Dr. F. J. Allen of Cambridge, Bryan was distinguished by "straightforwardness of character and generosity; by an ardent love of the beautiful in landscape, and for living things such as plants and insects which are so bound up therewith; by his great love of music, and the large part of his mind which it occupied." Bryan devoted much thought and experiment to the working of 'player' pianos, and invented an apparatus for accentuating any particular note or melodic passage. His two years of retirement at Bordighera were made happy by friendly intercourse with the Italian peasants, whose language he spoke so well, and 'Il Professore' was known and loved in many a mountain village far off the beaten track of the ordinary tourist.

S. BRODETSKY.

SIR ALEXANDER KENNEDY, F.R.S.

A NOTABLE figure in the engineering and scientific world is removed by the death of Sir Alexander B. W. Kennedy, F.R.S., in his eighty-second year. Born in London in 1847, the son of the Rev. John Kennedy, D.D., and Helen Stodart, sister of Prof. John Stuart Blackie, Kennedy received his early education at the City of London School and the School of Mines, Jermyn Street. In those early days there were no means of further education in his chosen profession of engineering, except by its actual practice, and for the next few years Kennedy was laying the foundations of his ultimate eminence as an engineer in the workshops and drawing offices of well-known firms of marine engineers in London and the north. In a surprisingly short time he was a leading draughtsman and an authority on the design and construction of the machinery of ships, and evincing thus early the keen judgment and sagacity in practical affairs which were so marked a feature of his character.

At the early age of twenty-seven, a turning-point in Kennedy's career was reached when he applied for, and obtained, the professorship of engineering at University College, London. It was a momentous step for the electors and himself, which was amply justified by events, for Kennedy proved to be an ideal professor as well as a notable pioneer in education and applied science. His outstanding educational achievement was his invention of the engineering laboratory as an essential part of a university course, a system which has spread all over the world and has proved so potent an influence for good in engineering education.

In his scientific work Kennedy was much attracted by the kinematic analysis of Realeaux, which he brought into prominence here by his lectures and his well-known text-book on "The Mechanics of Machinery." On the experimental side he became an authority in many branches of applied science, such as the scientific testing of boilers and steam engines, and also by researches on the properties of engineering materials and structures, for which he designed an autographic stress-strain recorder of great sensitiveness. As time went on, his advice and assistance on engineering matters were so much sought after that the strain became too great and he resigned his professorship in 1889 and went into practice as a