

Somewhat brusque in manner, Prince Galitzin endeared himself to all true scientists in this country by his intense enthusiasm, his frank and fearless expression of opinion, his great kindness, his appreciation of the work of others, and, perhaps not least, by his intense dislike of humbug.

A. S.

G. W. W.

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J. G. DARBOUX, 1842-1917.

JEAN GASTON DARBOUX, Permanent Secretary of the Paris Academy of Sciences, who died on February 25, 1917, was born at Nîmes on August 13, 1842, in a house which had once been a chapel of the cathedral. His father having died in 1849, he and his younger brother were brought up under the care of their mother, and their earliest education they received at the local Lycée, which they attended as day-boarders. In 1859 young Darboux entered the special class for mathematics at the Lycée of Montpellier, and in 1861 he headed the lists for admission to the École Normale Supérieure and the École Polytechnique. Of these two schools he chose the former, somewhat to the surprise of his friends, his decision being based upon a strong inclination towards the teaching profession, to which the École Normale was the recognised avenue. At that time Pasteur was the director of the scientific studies of the school, and he became interested in Darboux, whom he recognised as a promising recruit. Owing to the influence of Pasteur, after the usual three years' course, Darboux was enabled to remain two years longer as the holder of a teaching post created for him. During this period he gave decided evidence of his capacity for advancing mathematical science in the work he sent up to the professors of the school, and he made a profound study of the works of such writers as Monge, Gauss, Poncelet, Dupin, Lamé, and Jacobi.

In 1864 he published a note on orthogonal surfaces in the 'Comptes Rendus,' and in 1866 there was presented to the Sorbonne, as a thesis for the doctorate, his memoir "Sur les Surfaces Orthogonales." On the work contained in this thesis he received the congratulations of Chasles, Serret, and Bouquet.

In 1866-67 he assisted Bertrand in the work of the Chair of Mathematical Physics at the Collège de France, and during the years 1868-1872 he was Professor at the Lycée Louis le Grand, where Bouquet was his colleague. During this period his pupils were remarkably successful in attaining their practical aims, although the original form of his teaching

was such that its reference to the exigencies of examinations was only indirect. In 1872 he became Maître de Conférences at the École Normale, and in 1873 he became assistant to Liouville at the Sorbonne in the Chair of Rational Mechanics; among his pupils at this time were Appell and Picard. His already established reputation gave him considerable influence amongst the mathematicians of the École Normale, and his clear and elegant exposition of general mechanics at the Sorbonne did much to renovate the teaching of that subject in France. On the death of Chasles in 1880, Darboux was appointed as his successor in the Chair of Higher Geometry at the Sorbonne. His success not only as professor, but also as an organiser, led to his appointment in 1889, by the Minister of Public Instruction, on the nomination of his professional colleagues, as Doyen de la Faculté des Sciences de Paris, a post which gave full scope to his powers in the work of organisation of the University of Paris.

In 1884 he received the great honour of being elected member of the Academy of Sciences in the section of Geometry, the necessary report on his scientific work being composed by Jordan. In 1900 he succeeded Joseph Bertrand in his office of Perpetual Secretary of the Academy of Sciences. His remarkable powers as an administrator gave him a position of great authority in this position, in which he exhibited the most untiring zeal for the advance of science and for the prestige of the Academy. He excelled in the public orations which it was his duty to pronounce on the death of such members as Bertrand, Hermite, and H. Poincaré. He had the great satisfaction of seeing carried out the project, in which he had long been interested, of printing the MS. *procès-verbaux* of the sittings of the Academy since the foundation of the Institute in the year IX up to 1835, when the 'Comptes Rendus' were commenced. Up to the present, seven volumes, up to 1825, have been published; these are of special interest, as containing the work of Lagrange, Laplace, Monge, Cuvier, Lamarck, and other distinguished men.

For 17 years Darboux presided over the Society of the Amis des Sciences, a Society founded in 1857 by Baron Thénard for the purpose of aiding men of science in need of pecuniary help.

In his mathematical investigations, Darboux both originated new ideas, and also carried out detailed investigations on previously established lines. His expository style was artistic in form, and, while he knew how to utilise the detailed investigation of particular examples, in order to rise by observation and induction to generality of conception, his keen sense of proportion prevented any undue prolixity in his writings, and the detailed consequences of the ideas developed in some of his memoirs were left to be drawn by others. He possessed in a high degree the faculty of discerning relations between superficially diverse questions and methods, and thus of exhibiting the fundamental identity which often exists of theories originally developed independently of one another. His early work on orthogonal surfaces, in the course of which he discovered an orthogonal system of surfaces of the fourth degree, was contained in the thesis already referred to;

this subject, the importance of which, in relation to mathematical physics, had been traced out by Lamé, is one to which he frequently returned in later years.

In 1873 he published his researches on analytical geometry in a work "Sur une Classe Remarquable des Courbes et des Surfaces Algébriques." The principal aim of this work was the study of a class of surfaces, termed cyclides, which have as double line the circle at infinity. The work also deals with plane and spherical cyclics, and, in a note at the end, the differential equation of surfaces applicable to a given surface is formed. The theory of cyclides has been later shown to be of much importance in the theory of the solutions of Laplace's equation applicable to various classes of problems in the theory of the potential. A very remarkable and original memoir was published in 1876 on the approximation to functions of very large numbers. In this memoir, which is of importance in relation to applications in various directions, Darboux established methods for determining the order of magnitude of the coefficients of power-series from a study of the singularities on the circle of convergence, and he studied developments in series of polynomials arising from hypergeometric series. In 1870 there appeared the memoir containing Darboux's new method of integration of partial differential equations of the second order. This work, the most important on the subject since that of Ampère in 1818, has been of much influence in more recent investigations on the subject.

The memoir on discontinuous functions, published in 1875, with a supplement in 1878, contained a critical study of the Riemann definition of an integral, and established for the first time the existence of the upper and the lower integral of any bounded function; the memoir also contains various examples of continuous functions without derivatives. Darboux's monumental work on Differential Geometry, published in four volumes, between 1887 and 1896, under the title, 'Leçons sur la Théorie Générale des Surfaces et les Applications Géométriques du Calcul Infinitésimal,' contains, in a fascinating form, an account of his own researches in Differential Geometry, together with those of his predecessors. In 1898 he commenced the publication of his work, 'Leçons sur les Systèmes Orthogonaux et les Coordonnées Curvilignes,' which supplements and completes the earlier work.

In his geometrical work Darboux exhibits an unsurpassed power of combining geometry and analysis, so that the different points of view support and supplement one another. The theory of geodesic lines led him to consider various questions in Analytical Dynamics connected with the principle of Least Action. He published a memoir on the herpolhode and the theory of Poinot, and also wrote on the postulates of the statical proofs of the parallelogram of forces, and on the percussion and collision of bodies. He appended a series of elegant notes to an edition of Despeyrou's 'Cours de Mécanique.'

In 1904 he gave an historical lecture at the Exhibition at St. Louis, in which he sketched the progress of geometry in the Nineteenth Century. In

1908, at the Rome Congress of Mathematicians, he gave a remarkable discourse on the origin, methods, and problems of Infinitesimal Geometry. In the last year of his life he gave a course of lectures at the Sorbonne on the principles of Analytical Geometry, with special reference to the place of the Imaginary and the Infinite in Geometry. He intended that these lectures should be incorporated in a book to be edited by himself.

As Secretary of the Académie des Sciences, Darboux was brought into contact with other branches of science, and took an active part in international scientific organisations. At international meetings, which he frequently attended, his warm interest in the progress of science, the quiet dignity of his sympathetic personality, and his unfailing wisdom and tact helped to surmount difficulties and to ensure success.

Darboux was a member of a very large number of Academies and Scientific Societies, and was an Honorary Doctor of the Universities of Cambridge, Christiania, and Heidelberg. In 1900 he was elected a Foreign Member of the Royal Society, and in December, 1916, he was awarded the Sylvester Medal. This last recognition gave him genuine pleasure. The acknowledgment of its receipt was dictated a few hours before his death.

E. W. H.

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WILLIAM DU BOIS DUDELL, 1872-1917.

BORN in 1872, and educated in England and France, Duddell served his apprenticeship as engineer to Messrs. Davey, Paxman, and Co., of Colchester. He then went to the City and Guilds Institute at the age of 21. He stayed there for some years, as he found the facilities for experimental work were very good, and of exceptional value to him. Joubert had devised a method of tracing alternating pressure or current variations by balancing a series of phases of a period against a standard cell, by a potentiometer bridge. Duddell produced a galvanometer which is quick enough to follow the variations, and to show the curve by a light spot, or to photograph it. This brought him into prominence as a first-rate designer of special instruments.

The next important work was an investigation, with Prof. Marchant, of the ratio of the pressure to the current in the arc, generally called "the resistance." This led to the discovery of the singing arc. The singing arc is the basis of a system of generating continuous waves for wireless telegraphy. The arc is made to sing a note so high that it cannot be heard, but not high enough to be seen. The Poulsen generator is a development of this principle, and so is the valve type of transmitter.