

**Vito Volterra**, For. Mem. R.S., Hon. F.R.S.E.

ONE of the outstanding mathematicians of our time, Professor Vito Volterra, died at Rome on October 11, 1940.

Born at Ancona in 1860, Volterra began his university career at Florence in 1878, but soon transferred to the University of Pisa, where he graduated in 1882. At the early age of twenty-three he was elected to the Chair of Mechanics at Pisa, which he held for nine years. In 1892 he became Professor of Mechanics in the University of Turin, and finally, in 1900, he succeeded Beltrami as Professor of Mathematical Physics at Rome. During the War of 1914-18 Volterra volunteered his services and became an officer in the corps of Engineers, conducting experimental and theoretical investigations in aeronautics. From 1921 he was President of the International Committee of Weights and Measures.

The scientific work of Volterra covered many branches of analysis and mathematical physics. His publications, some two hundred in number, include substantial contributions to the theories of partial differential equations, the equilibrium of elastic bodies, optics, and mathematical biology. But the field which is associated primarily with his name is that of the functional calculus. This new development of analysis may be said to have been founded by him in a series of papers of which the first appeared in 1887; it has proved one of the most fruitful adventures in modern mathematics, and Volterra's work on it alone would entitle him to rank in the line of great mathematicians. Starting from functions, defined by partial differential equations, which depend not on a finite number of initial constants but on the infinite set of values given by functions defined initially, he was led to the new conception of *functionals*—or *functions of lines*—quantities whose value depends on the infinite set of values assumed by a given function. For these new functions, Volterra built up a new calculus—the functional calculus.

The methods of Volterra were rapidly diffused, and opened up new fields of research. The calculus of variations appeared now as a branch of the functional calculus, and was developed along new lines by Tonelli from this point of view. Integral equations arise in the theory of functionals, and Volterra's solution of the integral equations which now bear his name was the first general treatment of a class of integral equations. It thus paved the way for the whole theory of integral and

integro-differential equations, to which Volterra made many further fundamental contributions. The theory of permutable functions, the work of Fantappiè on analytic functionals, and the work of Moore and Fréchet on general analysis, all derive more or less directly from Volterra's ideas.

His first papers on mathematical biology appeared in 1926. They dealt with highly simplified mathematical models of systems of competing species. In numerous subsequent papers, and in his book *Leçons sur la Théorie Mathématique de la Lutte pour la Vie* (1931), he generalised the simple treatment, introducing many complications which would make the mathematical model a closer representation of the struggle for life in nature. The biological deductions have been strikingly verified in various ways; for example, in statistical observations of fish populations and the changes caused by cessation of fishing; and in *ad hoc* laboratory experiments, such as those of G. F. Gause on cultures of Protozoa. The subject of animal ecology has flowered intensively during the past two decades; and Volterra's mathematical contributions, along with the parallel pioneer work of W. R. Thompson and A. J. Lotka, have been an essential influence in its development.

Volterra lectured in foreign universities on many occasions. We may mention particularly a course on partial differential equations at Stockholm, the Vanuxem Lectures in 1912 at Princeton on permutable functions, and the lectures on functionals at Madrid. These latter formed the basis of his standard book on functionals, the English edition of which was published in 1930.

He was a man of vigorous personality and decided views. He refused in 1931 to take the oath of allegiance to the Fascist régime, required of all Italian professors. He was deposed from his Chair at Rome in consequence, and his compulsory resignation from all Italian scientific societies followed. Many of the most celebrated universities and learned societies of the world honoured Volterra. He visited Scotland on more than one occasion, and was given the Honorary Degree of LL.D. by the University of Edinburgh during the British Association Meeting of 1921. He was elected an Honorary Fellow of the Royal Society of Edinburgh in 1913.

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