JOSIAH WILLARD GIBBS

"JOSIAH WILLARD GIBBS was the son of Josiah Willard Gibbs (Y. C. 1809), the distinguished Professor of Sacred Literature in the University from 1822 to 1861, and of Mary Anna (Van Cleve) Gibbs. He was born in New Haven, Conn., on February 11th, 1839, and died on April 28th, 1903. He was prepared for college at the Hopkins Grammar School, New Haven, and entered the class July 24th, 1854. In his college course he won the Berkeley Premium for Latin Composition; 1857, Bristed Scholarship; 3rd Prize Latin Examination, 2nd term, Junior year; Berkeley Premium for Latin Composition; 1858, 1st De Forest Mathematical Prize; Clark Scholarship; Latin Oration.

"He occupied the first five years after graduation in 1858 in mathematical and other studies in New Haven. In the autumn of 1863 he became tutor in Yale, and was engaged with the duties of that position until August, 1866, when he went to Europe.

"The winter of 1866–67 he spent in Paris, and the winter of 1867–68 and the following summer, in Berlin, studying especially physics, but devoting a part of his time to mathematics. The winter of 1868–69 he passed in Heidelberg, and the next spring in France, reaching home in June, 1869. In July, 1871, he was elected Professor of Mathematical Physics in Yale."*

The prevailing interests revealed in Gibbs' work are those of a mathematician, though his facility in algebra was perhaps slight, and he was most successful when casting his arguments into graphical form. His mind was always straining towards complete general views. His direct geometrical or graphical bent is shown by the attraction which vectorial modes of notation in physical analysis exerted over him, as they had done in a more moderate degree over Maxwell, the interpreter of Faraday in this respect; his generalizing tendency was illustrated in the formal address, in which he expounded to the American Association the fascinations of the mathematical notations and operations appropriate to this subject, where he could not reach finality until his treatment had got into n dimensions of space. This bent towards exhaustive survey of his subject probably served Gibbs in good stead, by driving him to mathematical com-

* *Yale Alumni Weekly*, May 6th, 1903. See the Royal Society's Obituary Notice by Prof. Larmor, from which the present sketch is mainly taken.

pleteness in his exposition of thermodynamics, where others would have stopped short with the fragment of the theory that covered the physical applications then prominent or likely to arise. But his tendency to wind up the exposition and regard the account as closed when the logical fabric has been welded together, and to assign a subsidiary place to the details of such particular physical illustrations as then existed—from restraint, be it noted, not from lack of knowledge—retarded for many years the application of his methods by experimenters, to whom the behaviour of actual things is of more interest than the perfection of an abstract formulation of their relations.

The achievement by which Prof. Gibbs will chiefly be remembered is his development, into their full scope, of the fundamental principles which regulate equilibrium and the trend of transformation in inanimate matter in bulk, that is, in general chemical and physical phenomena.

Afterwards Gibbs turned his attention to the electrical theory of light, then in the tentative stage of development, and published in 1882 three papers in which the electrical relations forming the foundation of Maxwell's theory were expounded on the most general formal basis. The medium is taken to be heterogeneous (molecular) in its smallest parts, but of an averaged homogeneous structure as regards elementary regions of dimensions comparable with a wave-length. General linear relations of a formal type between the Maxwellian vectors are assigned, involving the case of rotational media when they are not self-conjugate. The precise part of the electrical basis utilised was the universally admitted general type of formula (Neumann-Maxwell) for the kinetic energy of the (circuital) displacement-currents in the field. The object of the papers was to point out how naturally the laws of optical reflexion, and of double refraction including its dispersion, flow from the electrical ideas as contrasted with the mechanical theory of Cauchy and Green. Thus the analysis is in some respects open to the remark that the electrical foundation is refined and generalized until there is but little distinctively electrical that is left except the frame; there remains a very general scheme of formal analytical relations, not unlike Hertz's later manner of conceiving the Maxwellian electrical equations, which has to become more restricted and particularised for practical use. In a subsequent paper he contrasted Lord Kelvin's remarkable labile mechanical æther, then recently announced, with electric theory in the same general manner, again laying stress on the formal optical fitness of the system of equations which are the expression of the latter. In all this work we recognize the same penetration and skill, in the formulation and expression of the utmost generality of outlook, which he showed in pure mathematics by his partiality for the

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study of generalized algebras and vectorial analysis, and which in thermodynamics has largely constituted the strength of his work, though at the same time it has retarded its absorption into the general body of scientific doctrine.

After a period in which Prof. Gibbs' work was much interrupted by ill health, he again appeared before the scientific world early in 1902 as the author of a notable treatise of 207 pages octavo, entitled *Elementary Principles in Statistical Mechanics, developed with especial reference to the Rational Foundation of Thermodynamics*, which was published in connexion with the Bi-centenary of the University of Yale. Having had a principal share in evolving the ultimate form of the principles that govern physical and chemical equilibrium, when matter in bulk is considered in terms of its observable properties alone, and having taken care to state them free of all vestige of molecular theory, it was natural that his thoughts should have turned to the less definite problems opened out by the molecular hypothesis of the constitution of matter, which provides a rational base for the axioms on which Carnot, Clausius, and Thomson originally built.

Prof. Gibbs, during his lifetime, was invited to honorary membership of most of the leading learned societies and academies of both hemispheres that pursue physics and mathematics. In particular, he became a Foreign Member of the Royal Society in 1897, and was awarded its crowning distinction, the Copley Medal, in 1901; he had been elected a Foreign Member of the London Mathematical Society in 1892.

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