BOOK REVIEWS

FROBENIUS, G., *The Collected Works of Frobenius* (*1849-1917*), edited by J.-P. Serre (Springer-Verlag, 1968), 3 vols., $34.00.

At the turn of the century, Frobenius was largely responsible for the pioneering work in the theory of group representations and characters. Although his early research was published in Crelle's Journal, the papers of his mature years appeared mainly in the Proceedings of the Prussian Academy. With the relative difficulty of obtaining the required volumes of the Proceedings and the current interest in group theory, it is a particularly opportune time to publish these Collected Works.

The three volumes are arranged in chronological order of publication, covering the periods 1870-1880, 1880-1896 and 1896-1917. Apart from the first item, which is Frobenius's Doctoral Thesis written in Latin, and a single excursion in French, all the papers are in German.

An interesting addition to the final volume consists of articles on Kronecker and Euler together with anonymous eulogies to Dedekind, Weber and Mertens. We are assured by the Editor that the unnamed author is Frobenius.

As to an appraisal of Frobenius himself, there is no biography nor mathematical commentary, but there is a revealing two page article by Carl Ludwig Siegel. This recalls the last two years of Frobenius's life when he was a Professor at Berlin and Siegel was a student.

At the beginning of his career, Frobenius was greatly influenced by Weierstrass, Kronecker and Kummer. With such an illustrious background, it is no wonder that his initial interests were in analysis and number theory. Modern textbooks contain many references to his work in these topics. For example the 'Frobenius method' for solving certain differential equations (1873) and the 'Frobenius automorphism' in the theory of fields (1896).

Very early on he developed an interest in abstract algebra and approximately one third of the papers in the first volume of his works are concerned with linear algebra and group theory. They include, for example, " Über Gruppen von vertauschbaren Elementen " written with L. Stickelberger (published 1879); this classifies finite abelian groups as direct sums of cyclic groups of prime power order. The rest of the work in this volume includes papers on differential equations and elliptic functions.

The first half of the second volume concerns analysis (including papers on elliptic functions, theta functions, Jacobi functions and other topics) but the second half becomes more involved with algebra. This carries over into the last volume which is completely dominated by algebra and contains the work on representations and character theory. Numerous references occur in the current literature (the " Frobenius Reciprocity Theorem " (1898), " Frobenius algebras ", " Frobenius groups ", various " Frobenius theorems " etc.).

Burnside, in his book on " Groups of Finite Order " (1911), attributed much of the early research on representations and all the early theory of characters to Frobenius. More than half a century later, Curtis and Reiner paid tribute to this work in the Preface to " Representation Theory of Finite Groups and Associative Algebras ". They state that " the theory of group representations was developed in an astonishingly complete and useful form by Frobenius in the last two decades of the last century ". This edition now makes his work readily available in its original form.

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