

SHORTER NOTICES.

Bibliography of Quaternions and Allied Systems of Mathematics. By ALEXANDER MACFARLANE. University Press, Dublin, 1904.

THE International Catalogue of Scientific Literature places the following branches of mathematics under the head of universal algebra: (1) calculus of operations. (2) general theory of complex numbers. (3) quaternions. (4) Ausdehnungslehre and vector analysis. (5) matrices. (6) other special sorts of complex numbers. (7) algebra of logic.

The work under review contains a bibliography of topics 2, 3, 4, and 5. Titles in which vector ideas and methods are applied are also included. Although the subject of bilinear forms is not mentioned in the International Catalogue, Professor Macfarlane very properly includes certain titles in this field which deal with the theory of matrices. It is an extremely difficult matter to prepare a complete bibliography for a field as wide as Professor Macfarlane has chosen, and his approximation will be keenly appreciated, especially by those to whom large libraries are not accessible. The fields of quaternions and vector analysis seem to be carefully covered. In the allied branches of general theory of complex numbers and matrices the bibliography is not so complete, though most of the fundamental memoirs are noted. A partial list of omissions is appended, which contains among others important titles by Weierstrass, Frobenius, Molien and Dedekind.

CARTAN.

1897. "Sur les systèmes de nombres complexes." *Comptes Rendus*, page 1217.
 1897. "Sur les systèmes réels de nombres complexes." *Comptes Rendus*, page 1296.
 1898. "Les groupes bilinéaires et les systèmes de nombres complexes." *Annales de la Faculté des Sciences de Toulouse*, volume 12, page 81.

DEDEKIND.

1885. "Zur Theorie der aus n Haupteinheiten gebildeten complexen Grössen." *Göttinger Nachrichten*, page 141.