Chicago Congress through their generous contribution to the Lobachèvsky memorial fund, contains the promise of a still closer union between the mathematicians of America and Russia, and proves the solidarity of scientific interests among all nationalities.

KAZÀN, *March* 7, 1894.

MACFARLANE'S ALGEBRA OF PHYSICS.

Principles of the Algebra of Physics. By A. MACFARLANE, Professor of Physics in the University of Texas, Austin, Texas. *Proceedings of the American Association for the Advancement of Science,* vol. 40, 1891, 53 pp.

On the Imaginary of Algebra. By A. MACFARLANE. *Ibid.,* vol. 41, 1892, 23 pp.

THE purpose of the first of the articles which are to form the subject of this review may most properly be stated in the author's own words: "The guiding idea in this paper is generalization. What is sought for is an algebra which will apply directly to physical quantities, will include and unify the several branches of analysis, and when specialized will become ordinary algebra."

A student who sets out to use Grassmann's algebra in geometrical work finds that it applies beautifully to projective problems in curves and surfaces of no higher order than the second, but beyond them he is confronted and stopped by difficulties which can be overcome only by the study of the ordinary theory of algebraic forms. In the same way quaternions work out many metrical properties of curves and surfaces with facility and grace, but I think every student who has tried to go far with them finds that he is at last brought back to the study of the equations and functions of ordinary analysis. There seems to be no way around the difficulties of the theories of forms and functions, and even when results have been attained by methods which appear to avoid them the mind is seldom convinced of their validity. As we shall see, Professor Macfarlane derives the formulas of trigonometry with great facility, but it seems almost certain that no analyst would dare to use them if they had no other foundation.

Passing by considerations of this kind which seem to make it doubtful whether or not any system of analysis other than the ordinary one can do much to advance mathematical science, we come to the author's first objection to quaternions