

no other living scholar had done more than he for the study of the "Book of the Dead," both by the publication of new material and by the interpretation and translation of the entire work. The present volume is unique in its own sphere, and no private individual or firm of publishers could have undertaken the responsibility of such a production. The Trustees have earned the gratitude of scholars by making so much new material available for general study, and they are to be congratulated on the production of a monumental work which worthily carries on the scholarly traditions attaching to the Museum at Bloomsbury.

HAMILTON'S QUATERNIONS.

Elements of Quaternions. By the late Sir W. R. Hamilton. Second edition. Vol. I. Edited by C. J. Joly. Pp. xxxiii + 583. (London: Longmans, Green, and Co., 1899.)

FOR many years Hamilton's "Lectures" and "Elements" have been out of print, and the ardent student of quaternions was oftentimes unable to secure a copy of either of these great classics. Prof. Tait's treatise on quaternions is probably a better introduction for the beginner, who is more quickly brought into touch with the essential spirit of the method than he would be in Hamilton's pages. But he must, some time or other—unless he be a second Hamilton—bathe his mathematical being in the inexhaustible streams of quaternion analysis and symbolism that flow from the great master's mind. A second edition of Hamilton's immortal work is therefore to be warmly welcomed. English-speaking students will now be able to study Hamilton freely without having recourse to French or German translations; and it is our hope that the issue of this second edition will lead to a wider appreciation of the value of quaternions as a mathematical method peculiarly adapted to the geometry of space and general problems in dynamics.

The new edition is printed by direction of the Board of Trinity College, Dublin, and is edited by Prof. Joly. In the larger size of page and larger and wider type there is a great improvement on the original form, although it has necessitated dividing the book into two volumes. The small print has been done away with altogether. This, in itself, no doubt is better for the reader; but the advantage is lost that he can no longer discern at a glance what is illustration and particular from what is general and fundamental. For example, in the very important sections on the linear and vector function, one of the most beautiful of Hamilton's creations, the reader cannot pick out so readily as in the original edition the broad line along which the fundamental properties of this function are developed. Many of the illustrations are really of the character of examples, such as Prof. Tait puts at the end of his different chapters. Printing these in the same style as the more important parts tends to give them a fictitious value, and to blur the whole perspective of the book.

The editor has added occasional notes to elucidate points which might appear obscure to the student. In some of these a different line of proof may be suggested, or they may simply amount to a reference to another

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section. Prof. Joly has exercised this editorial function with judgment. One of the longest of these notes is appended to the chapter on the well-known i, j, k relations, and brings out clearly the necessity for the negative sign of the square of a vector, *if the associative law in products is to hold*. The system which is built on the assumption that $i^2 = j^2 = k^2 = +1$ is ascribed to Mr. Oliver Heaviside. It ought, strictly speaking, to be ascribed to O'Brien, a contemporary of Hamilton's.

We are not called upon at this date to consider the merits of Hamilton's great calculus. The objections taken to it by mathematicians great and small have been so curious and, in some cases, so puerile that we doubt if these critics have ever seriously set themselves to study its true character. One really eminent mathematician who had been fortunate enough to pick up a copy of Hamilton's "Lectures" for a trifling sum, gladly transferred his prize next day to a friend, remarking that the man must have been mad who invented quaternions, for he made two sides of a triangle equal to the third side! Maxwell adopted the compact suggestive notation in his "Electricity and Magnetism"; and many of the transformations which are so necessary now-a-days in connection with electromagnetic waves, and take a page or two to effect in ordinary notation, are done almost by inspection by quaternion methods. Maxwell did not use the quaternion method, not because he regarded it as inferior to the notation, as one writer has with curious logic argued, but simply because the world was not ready for it. Let us hope that with this handsome re-issue of one of the most characteristic works of our century a renewed interest will be taken in the study of quaternions, so that in the near future operations and notations alike may be freely used in works on mathematical physics. Prof. Joly deserves the gratitude of all for his labour of love. When we remember the peculiar characteristics of Hamilton's style, with its redundant italics and capitals, we realise the hardness of the task the editor has set himself in reproducing to the letter (barring misprints) this great monumental work.

One word in conclusion. Is no new edition of the "Lectures" to be brought out—or at any rate of Lecture vii., which is nearly as long as the other six put together? A re-issue of Lecture vii., with perhaps an introductory chapter giving the fundamental principles of the calculus, would confer a boon on many students. In this so-called "Lecture," the great mathematician moves with a giant stride over the greater part of the whole field of geometry and dynamics. From it alone Tait drew his inspiration. C. G. K.

OUR BOOK SHELF.

A Short History of the Progress of Scientific Chemistry in our own Times. By Prof. W. A. Tilden. Pp. x+276. (London: Longmans, Green, and Co., 1899.)

IN size and scope Prof. Tilden's short history recalls Wurtz' brilliant little "History of Chemical Theory," published thirty years ago. But whereas the key-note of Wurtz' book was the "immortal memory" of Lavoisier, and its main theme the vindication of French chemists *contra mundum*, the spirit of Dr. Tilden's book lies in its impartiality and sound judgment. In mode of