Review
Author(s): Philip E. B. Jourdain
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REVIEWS.

A Treatise on the Analytical Dynamics of Particles and Rigid Bodies; with an Introduction to the Problem of Three Bodies. By E. T. WHITTAKER. Second Edition. Cambridge: University Press, 1917. Pp. xii, 432. Price 15s. net.

This new edition of Prof. Whittaker's valuable and well-known treatise is not very greatly different from its first edition of 1904. The author has "endeavoured to give references to, and in some cases accounts of, the numerous original researches in Dynamics which have been published by various investigators since the first edition appeared." Further, he has "added some historical matter, and rewritten many sections" (p. v). The chief alterations will be mentioned further on. The sixteen chapters deal respectively with kinematical preliminaries; the equations of motion; principles available for the integration; the soluble problems of particle dynamics; the dynamical specification of bodies; the soluble problems of rigid dynamics; theory of vibrations; non-holonomic systems and dissipative systems; the principles of least action and least curvature; Hamiltonian systems and their integral-invariants; the transformation-theory of dynamics; properties of the integrals of dynamical systems; the reduction of the problem of three bodies; the theorems of Bruns and Poincaré; the general theory of orbits; and integration by trigonometric series. The chief alterations are a new explanation of the transformation-theory of dynamics and Hamilton's work—his earliest original work—on the characteristic function (pp. 288–92); the changes in the treatment of the motion of a body about a fixed point under no forces (pp. 144–52), which arise from Prof. Whittaker's opinion that the Jacobian elliptic functions are preferable to the Weierstrassian ones in numerical computations; and the short account (pp. 411–2) of Sundman's theorem on the regularisation of the problem of three bodies, which is meant to inspire the student to read Sundman's original paper.

In the following criticisms some of the points criticised belong to the first edition as well as his second one, but it seems relevant to point out statements which, it seems to me, ought to have been altered. The addition to this edition (p. 26) stating that the opinion of the nineteenth century was that the aether was on the whole stagnant and that, in the opinion of the author, "this doctrine has been subverted by the modern Principle of Relativity," seems to be of no value when put in such a magisterial form. The introduction (p. 29) of the equations of motion suffers from a defect shared with many text-books of putting a student in the puzzling position of being told by implication that these equations, on which the whole theory of dynamics is founded, are identities. I doubt the statement in the note on p. 34 that Lagrange's equations were first suggested in his early paper of 1760; in any case Prof. Whittaker should have given a rather more detailed justification for such a revolutionary statement.

The one other criticism which it seems to me should be made happens to be on that small part of the subject on which I have worked a good deal. It is not important from the point of view of the actual integration of mechanical equations, and it is chiefly in being an account of the latter subject that the great value of the present book consists. But the fact that no help is given to integration does not make a discussion unimportant in itself: witness Hamilton's partial differential equation. If, then, I speak about my own work, it is merely because I think that some points were brought forward in it which are not unimportant—and relevant even to Prof. Whittaker's own treatment. I think I can point out this in a few words. In the note on p. 249 there is a reference to some work by Voss in which an intention was announced of applying Hölder's process of thought to the case of general co-ordinates. In a paper in the *Mathematische Annalen* for 1908, which was the result of four years' work and controversy, I showed that Hölder's method is not used by Voss, and gave the approximate extension of Hölder's method. This extension does not happen to be immediately obvious and it brings out

the difference in the process of "variation" used in Hamilton's principle and the principle of least action and in each one when the dynamical system ceases to be holonomic, which is nowhere pointed out by Prof. Whittaker (pp. 245-50), although Hölder's extension of both these principles, which was carried out by him for rectangular co-ordinates alone, to the case of non-holonomic conditions is supposed to be described. However, all these criticisms do not touch the very great value of the book which has been and will be the chief path by which students in English speaking countries have been and will be introduced to modern work on the general and special problems of dynamics. PHILIP E. B. JOURDAIN.

Mathematical Monographs. Edited by M. MERRIMAN and R. S. WOODWARD. No. 17.

Lectures on Ten British Mathematicians of the Nineteenth Century. By ALEXANDER MACFARLANE. First Edition. First Thousand. Pp. 148. 5s. 6d. net. (Chapman and Hall.)

The present volume, we are delighted to hear, is the first instalment of twenty lectures given at Lehigh University some years before the author's lamented death. Macfarlane belongs to the little band of men who were proud to own allegiance to their teacher Tait, and he will be best known to a large number of mathematicians as a founder, as an industrious and active official, and ultimately as President of the *International Association for the Promoting the Study of Quaternions.*

It is much to be regretted that proper attention was not paid to the editing of the present volume. The publishers could have easily secured a competent person at least to identify easily verifiable quotations; more than one of them contain many misreadings, *e.g.* in Maxwell's line "around his head in *endless* cycles run," where Maxwell no doubt had his own reason for preferring "ceaseless," and a few lines further down where the sentence becomes sheer nonsense: "Above the host where your emblazoned rolls," where "wave" should take the place of "where." We are sure that Cayley was neither so discourteous nor so waggish as to allude in his own Presidential Address at a British Association meeting to the "providential" addresses of his predecessors (p. 69), and Tait must have had an impossible cross between the great giants of the city of London in his mind if ever he—a Scotchman and steeped in the Scriptures—was responsible for "He spared Agog, and the best of the sheep." Passages which are quotations are quoted as the words of the lecturer. A note on p. 82 to the well-known saying of Newton: "If Mr. Cotes had lived we might have known something," which apparently had for the moment escaped Macfarlane, should have been added. Letters are blind, and are omitted with irritating frequency (cf. pp. 87-88) or unnecessarily inserted, as in the generally abandoned form "Clairault," pp. 10, 35 and 147; "mathematicas," p. 65; words are omitted even where the sense is obviously destroyed (cf. "won't do" for "this won't do," p. 88). We have J for I in the anagram which, following ancient custom, was sent to *Nature* by Tait under the name of West, after to be explained in "The Unseen Universe." We have "plain" for "plane" (p. 87), "Lionville" for "Liouville," * within half a dozen lines of each other "Leibnitz" and "Leibniz"; an unintelligible notation is attributed to the German philosopher, and any decent compositor would be ashamed to leave uncorrected a reference to a "sovereing" and a feather. On p. 120, for 1872 read 1892. To call George Ticknor a scientist (p. 43) is a curious inversion of the current blunder which consistently confuses a "scholar" and a "savant" (what shall we call a savant who is also a scholar?). But poor Macfarlane was not responsible for most of these blemishes, and let us say at once that the volume is one which mathematicians who care to know something of the personalities of those who contributed so much to the progress of the science will read with pleasure almost unalloyed.

* The *n* and *u* are fatal to unsuspicious compositors. A victim draws our attention to Ronth, Enler, Darbonx, Pinsenx, ...