may be mentioned the following: singular points of algebraic curves, differential equations and invariants, elliptic functions, theory of numbers, and theory of series.

For a brief sketch of the life of Halphen, with some remarks on the character of his work, the reader may consult the *Notice* by Picard (vol. I, pp. vii–xvi). In the *Notice* by Poincaré (vol. I, pp. xvii–xliii) we have an excellent systematic analysis of his mathematical contributions. Besides this there is the *Notice* by Halphen himself (vol. I, pp. 1–47) in which his own contributions were analyzed on the occasion of his candidacy before the Paris Academy of Sciences in 1885, about four years before his death. These excellent brief accounts of his work relieve the reviewer of the duty of making an analysis of the separate memoirs. The entire works (with the exception, apparently, of the *Traité des Fonctions Elliptiques*) are to be included in four volumes, of which the third is announced as in press and the fourth in preparation.

R. D. CARMICHAEL.

A History of the Conceptions of Limits and Fluxions in Great Britain from Newton to Woodhouse. By Florian Cajori. Chicago, The Open Court Publishing Company, 1919, pp. viii + 299.

This work appears as number five in the Open Court Series of Classics of Science and Philosophy, a series which should meet with all the encouragement and support that American scholars can give in these times, when the question of the publication of such works is so critical. That such encouragement and support is justified may be seen from an examination of this latest production of Professor Cajori's pen, for he has here given to scholars one of the best of his various studies in the history of mathematics.

The work consists of twelve chapters under substantially the following titles: I. Newton; II. Printed books and articles on fluxions before 1734; III. Berkeley's *Analyst;* IV. Jurin's controversy with Robins and Pemberton; V. Textbooks immediately following Berkeley; VI. Maclaurin's *Fluxions* (1742); VII. Textbooks of the middle of the eighteenth century; VIII. Robert Heath and the controversy in his time; IX. Abortive attempts at arithmetization; X. Later works on fluxions; XI. Criticisms under the influence of

French writers; XII. Merits and defects of the early fluxional conceptions. The work has a good index which students will find helpful in the matter of ready reference.

The two features of the work that will appeal to the student as of paramount importance are the selection and arrangement of original material and the translations which accompany the Latin texts. For good or ill, the ability of American scholars to read Latin easily has departed; and although the original Latin forms are desirable for reference, either a translation or an explanation of some kind has now come to be a desideratum, if not a necessity. Professor Cajori has placed students under great obligation for searching out with care the passages in Wallis, Newton, and others who played leading parts in the perfecting of the calculus, and in presenting these passages in a manner that renders them accessible to all who care to consult them. Here the reader will find the early symbolism, the definitions, and the methods of approach that are necessary to an understanding of the numerous controversies that agitated mathematical England, with respect to the calculus, for more than a century.

In the first chapter Professor Cajori has given numerous excerpts from such works of Newton as appeared before 1734, the date of Bishop Berkeley's attack upon the whole theory of fluxions. These are chiefly from the *Principia* (1687), from Newton's *Quadrature of Curves*, which Wallis first published in his Algebra (1693), from the *Commercium Epistolicum* (1717) and from certain letters and manuscripts. These extracts show that Newton made use of infinitesimals as early as 1665, that he used the dot notation in the same year, that he first used the word " fluxion " (at least in print) in 1687, that he used the idea of limits in 1687, and that he finally placed his theory on a thoroughly logical basis in the 1704 edition of his *Quadrature of Curves*. The summary is a particularly lucid one of the steps taken by Newton in his development of the calculus.

The literature upon the subject which appeared in Great Britain between 1686, when John Craig published his *Methodus Figurarum . . . quadraturas determinandi*, and 1734, when Berkeley's *Analyst* appeared, is next considered. Professor Cajori shows that the influence of Leibniz was much greater in England than is generally suspected, and shows that the clashing of the two different methods of attack, the New-

tonian and the Leibnizian, gave to Berkeley an excellent opportunity for "the most spectacular event of the century in the history of British mathematics." Mathematicians are generally aware of the fact that this attack was made, but the details are rarely known. Berkeley's *Analyst* is not a common work, although it is occasionally offered by dealers in the classics of the eighteenth century. For this reason the careful summary here given will be welcome to those who care for the genesis and early status of great movements in the field of their favorite science. The extracts from Berkeley, for example, have been carefully copied, although the author has taken certain justifiable liberties in the matter of punctuation, spelling, and capitalization.

A further service rendered by Professor Cajori is seen in his chapters on the books on the fluxional calculus that appeared after Berkeley's attack; many of them, no doubt, being the natural result of such criticism, the authors appearing as champions for a cause that seemed to them worthy of strong defence. For the interesting details of this defence, and for the subsequent fortunes of the fluxional type of analysis, however, the reader should consult the work itself.

The mathematical world has often been in debt to Professor Cajori for his detailed studies, but never more so than in this case.

DAVID EUGENE SMITH.

Cours de Cinématique théorique. By H. Lacaze. Paris, Gauthier-Villars, 1920. 138 pp.

This text is for the use of students of the lycée and the government schools. The first part of the book covers 56 pages, the complementary part 82 pages. In the first part are five chapters entitled, respectively, vectors, kinematics of a point, movement of a solid and distribution of velocities, composition of accelerations, and displacement of a vector in a plane. The complementary part has five corresponding chapters. Vectors are represented throughout as triples, no real vector notation entering the book. The first part is elementary, the complementary part is more advanced. Explanations are brief but sufficient, and a few exercises are introduced which help out the book for student use. It is clear, well-printed, and ample for a beginning course.

JAMES BYRNIE SHAW.