astronomer. The problem of the determination of an orbit from three observations is not exactly an enticing one. It is a tiresome piece of analysis which appears to offer little scope at the present time for the aspiring mathematician. In the case of a parabolic orbit the solution can even be made without successive approximations as M. Poincaré points out in the preface. In the case of an elliptic orbit, almost the only point of mathematical interest is the presence of a transcendental equation.

The treatises on this subject are well known, if not numerous. Gauss, in his Theoria motus, laid the foundations of the method at present in practical use, while Laplace a short time before had given a different form of solution. In the preface to the 'Leçons,' M. Poincaré has devoted some space to showing that Gauss's method is really equivalent to that of Laplace in spite of their apparent dissimilarity. The former has, however, been fully worked up with tables and formulæ for practical use in the great treatises of Oppolzer (of which there is a French translation) and Watson. In spite of the fact that a computer who has at his finger ends the notation and formulæ given in either of the last named volumes, will probably not care to change to another, M. Tisserand's work may nevertheless be found of use. The equations are developed quickly and easily, and moreover are all put together in a form which admits of immediate application. The young astronomer, unless he has acquired a firm grasp of his mathematics, may perhaps find it somewhat difficult to see the bearing of all the formulæ owing to the brevity of the explanations.

There are two chapters. The first on the method of Olbers for the determination of the orbit of a comet from three observations; the second on Gauss's method for the similar determination of the orbit of a planet. A numerical example of the latter, fully worked out, is set forth, showing the form in which the calculations would be actually made. Tables VIII and IX of Oppolzer's treatise are reproduced.

ERNEST W. BROWN.

Vorlesungen über mathematische Physik, Band I, Mechanik. Von GUSTAV KIRCHHOFF. 4te Auflage von W. WIEN. Teubner, Leipzig.

KIRCHHOFF's four volumes on mathematical physics which have appeared at various times since 1876 are so well known that little need be said about them here. The first volume on general mechanics has already reached its fourth edition. The second and third editions were issued under the superintendence of the author. Dr. Wien has had the advantage of the author's manuscript notes, found after his death, in preparing the volume for the fourth edition. No changes have, however, been made beyond the correction of printer's errors and the removal of slight obscurities. One of the best testimonies that we can give to the care and ability which Kirchhoff devoted to the original volume is to say that those who possess any one of the first three issues will not find it necessary to buy this last edition.

ERNEST W. BROWN.

Leçons élémentaires sur la théorie des formes et ses applications géometriques, a l'usage des candidats a l'agregation des sciences mathematiques. Par H. ANDOYER. Paris, Gauthier-Villars et Fils, 1898. 4to, 184 pp. Lithographed.

THIS title represents accurately the contents of the book. A restricted list of topics is adequately treated. Geometrical applications are plentiful but do not encroach upon nor obscure the purely algebraic theory. The treatment is perhaps elementary, but in style simplicity is less noticeable than brevity. The work as a whole is more nearly a syllabus than a textbook for the beginner, and as a syllabus it cannot fail to become widely known and valued.

Binary and ternary forms are introduced, but of binary forms only linear, bilinear, quadric, cubic, and quartic forms are discussed; and of ternary, only linear, bilinear, and quadric. The bilinear ternary form in cogredient variables I do not remember having seen in any earlier text, although Salmon's Higher plane curves gives a brief geometrical discussion of skew reciprocity; its inclusion here together with the form bilinear in contragredient variables must be commended by geometricians. Duality as a method stands certainly on a par with projectivity.

Two points of excellence are worthy of special mention. The first is that from the outset stem forms are assumed to contain several sets of variables; and this convention is observed in the case of each particular form, an unlimited number of sets of cogredient variables being adjoined. Of course this amplifies the complete system of each stem form, but the extension is easy, since no new types occur. The second novel merit is that the term *polar* is so defined as to include such operations as Aronhold's. If so-called variables are replaced by cogredient variables, the process is ordinarily called a polar operation, and M. Andoyer sees no