but there does not seem to be sufficient reason for the innovation of giving it half its usual value, considering how much confusion this may make. The same remark applies with less force to curl. The resuscitation of Lamé's first and second differential parameters is also of doubtful advantage; they are not suggestive names. But any way Professor Webster has a better notion of providing enough suitable names for the things he has to talk about than most writers on the subject. He might, especially in writing for physicists, make more use of the conceptions thus expressed to gain conciseness and vividness of statement, and to avoid cumbrous and unnecessary mathematical work; but it is clear that he does not care for conciseness, and that it is not his plan to take any course which could have the appearance of being a short cut, even though it may be one which has a good right to be regarded as the high road.

His account of Helmholtz's theory of vortex motion is a case in which he puts the reader on the right track at the outset: the point to which he calls attention here being the idea of analysing a vector distribution into two components, one lamellar and the other tubular. But he is surely wrong in attributing this analysis to Helmholtz. It was given in exactly the same form by Stokes nine years before Helmholtz's theory of vortex motion was published; see Stokes's papers, vol. ii, p. 254. Here the expression of the tubular component as a curl, that is to say the discovery of the vector potential, is an essential point; but apart from this, the fact that the analysis is possible may be very easily seen. Suppose any vector distribution to be represented in magnitude and direction by lines, forming a fibrous structure in which lines begin and end as is required by the variations of magnitude. Add to this what is necessary to make the system tubular by splitting up each line, at the point at which it ends, into radii uniformly distributed in all directions, and similarly drawing a system of radii up to the point at which each line begins. The system thus added, taken by itself, is lamellar; accordingly the original system is analysed into the tubular system which has been constructed and a lamellar system consisting of the added part reversed. The case of the analysis of 4π times magnetization into magnetic induction and magnetic force reversed is of course an example of this. But there is an advantage in the matter of clearness in getting the geometrical conceptions separated from their physical applications.

There is much in Professor Webster's book which is commendable for thoroughness. For example, in dealing with the flexure and torsion of prisms, we are plunged at once into St. Venant's theory, and are not allowed a chance of entangling the elastic line with any speculations about cross sections in flexure remaining plane.

The treatment of rotating bodies, including tops, and the author's own contributions to the experimental verification of such motions, deserve special attention. W. H. MACAULAY.

Eléments de la Théorie des Groupes Abstraits. Par J. A. DE SÉGUIER. (Paris, Gauthier-Villars), 1904.

This is the short but full first part of a contemplated work of which the master-title is "Théorie des Groupes Finis." The whole will

clearly aim at completeness, so far as present knowledge goes. The present part is difficult reading because of extreme compression, and also because the order of arrangement has been decided by considerations of abstract thought rather than by naturalness of discovery. A principle usually adopted by French authors is that a work worth making public at all is worth writing in sufficiently expanded form, and printing with sufficient prodigality of space, to make it attractive and convincing to those to whom its ideas are new. Lucidity is put on a par with exactness, and to be lucid without being wearisome is to effect a triumph of art. On our side of the channel views as to artistic expression have too often been different. Not to use a word too many, not to waste two lines over an analytic expression which inventiveness in notation can confine to one, have been aims with which we are too familiar. We thus deter scores from gathering anything from what we offer, and comfort ourselves with the belief that the very few who do spend a considerable fraction of a life-time in ascertaining what we mean must really thereby master the subject dealt with, because practically forced to investigate the full content of every sentence for themselves. M. de Séguier seems to have discarded as vanity the pride of his compatriots, to have adopted our false canon of art, and even to have succeeded in outdoing us.

The word "Finis" in the master-title appears redundant. It hardly prepares us to find the preliminary chapter in the introductory volume devoted to infinite assemblages: to an arithmetic in which the two cardinal numbers having prominence are ∞ and ∞^{∞}. The finite is to be studied as a special variety of what is generally transfinite. The once intelligible word "Eléments" also does service in a sense even less elementary than has become usual. We have grown accustomed to a lax use of the term which we associate with diffidence on the part of authors. A comprehensive treatise is often quite unnecessarily, and even misleadingly, described on its title page as one on the elements of a subject, because it starts from the beginning, and the author is aware (as all must be who know what they are talking about) that he has not said the last word possible. But here the word marks no condescension to the beginner at all. Easily grasped ideas are crude, and savour of the concrete. The view has been adopted that it is unscientific to disclose how these have been analysed, and thought has passed back from them to more abstract ones which they involve. On the contrary, fix upon the utmost thinkable which has been passed back to, do your best to reduce it in full generality to the stateable, and call the result an elementary idea. Reason from it as you can, avoiding all acknowledgement of concrete fetters as means of holding it, and so develop what you may call the elements of a theory. Presently descend to things concrete, to the simpler ideas which will help the ordinary human mind in its efforts to grasp the "elementary" conceptions which have preceded. The descent is to be made in the next volume under the heading "Compléments."

The book is to be admired as consistent and masterly. The above remarks are not intended as adverse criticism—many will regard them as amounting to high praise—but as allegations in support of the

present reviewer's opinion that had the author been less careful to avoid diffuseness, and less determined in his adherence to a lofty ideal of rational arrangement, he might have appealed to a wider circle of readers, and have supplied a want of which many are conscious, while still serving higher purposes. All who have thought about groups and aggregates, and want to possess in compact compendium what they know and should know, will welcome the present volume and desire the early appearance of the "Compléments." We share their feelings of welcome and expectation; but at the same time feel more strongly than ever that there is urgent need of a popularizing introduction to abstract group theory, a book which will aim in the first place at awakening, and only secondarily at satisfying, enthusiasm for the subject. E. B. ELLIOTT.

Die Lehre von der Zentralprojektion im Vierdimensionalen Raume. By Dr. H. DE VRIES. Pp. 78. (Leipzig, Göschen.)

The straight lines which join any point O to all points of a plane trace out a space of three dimensions, and, conversely, the properties of the space may be studied by means of its projection from O on the plane. Similarly, we may project a space of four dimensions from O on to a three-dimensional space and obtain its properties, though the process is naturally more complicated. The author works out this idea in detail, starting with Schoute's "Mehrdimensionale Geometrie" and Fiedler's "Darstellende Geometrie" as his basis. The first part of the book is occupied with a general discussion of the projection, the vanishing points of lines, etc.; then comes the theory of perpendicularity and a series of fourteen fundamental constructions, *e.g.* the line of intersection of a plane and a space, the distance of two points, and so on. H. H.

Mathematische Einfuhrung in die Electronentheorie. By A. H. BUCHERER, University of Bonn. (Teubner.)

The idea that the phenomena of electrolysis are produced by the transference of small portions of matter carrying an electric charge, is familiar to every student of physics. The discovery that in part of the phenomena of the vacuum discharge we are concerned with the motion of charged portions of matter which have a smaller mass than the ordinary chemical atom, has led to a profound change in our ideas of the constitution of matter. The attention of mathematicians has thus been strongly directed to the study of the motion of small charged systems in accordance with the electromagnetic equations of Maxwell and Hertz, for the question has an important bearing on spectrum analysis and radio-activity.

The problem is one of great difficulty and has not yet been solved in general. At present it must be regarded as in a tentative stage, and thus any book on the subject with any pretensions to accuracy, must involve a constant appeal to experiment.

Dr. Bucherer has been very happy in his treatment of the subject. By using vector notation he has reduced the mathematical symbolism considerably and has thus been able to present the results of mathe-