inspection. An examination of the bibliography in Ahrens's Mathematische Unterhaltungen und Spiele, to take a relatively unimportant case, shows how weak is § 313, Mathematische Belustigungen.

The misprints are too numerous to consider, except as types. T. L. Heath appears as R. D. Heath, author of a life of App*o*llonius, with no mention of his other works. McCormack's translation of Schubert, published at 75 cents, is assigned to MacCormack and the price is given as $3.75. Professor John Dewey appears as A. Dewey, Professor Cajori as Cajory, a good English Euclid as Euclide, H. N. Robinson as H. or N. H. Robinson, and G. A. Wentworth as G. H. Wentworth. Arithmetic appears as arithmetics, "another" as "an other" (page 192), and McLellan as MacLellan (page 8), and the many other errors of this kind in English show that similar ones may be expected in other languages. The same carelessness is seen in the index and the cross references, there being no mention of Lagrange (as indexed) on page 139, the Braunmühl cross reference (page 1) 188 being an error for 181, and the reference to page 357 in the Inhaltsverzeichnis being an error for 358.

Since a definite basis of classification, a careful selection of material, and a minimum of typographical errors are essential if a work of this kind is to be recognized, there can be but one opinion of this attempt of Professor Wölffing, that it will take no rank as an authority in the field of mathematical bibliography.

DAVID EUGENE SMITH.

Elemente der Vektor-Analysis. Von A. H. BUCHERER. Leipzig, B. G. Teubner, 1903. vi + 91 pp.

VECTOR analysis has been attracting to itself each year more and more attention in Germany. Up to the present year no account of the subject had been published in separate form except the bulky classics little suited to the actual needs of the practical physicist. Dr. Bucherer has supplied the deficiency admirably so far as he goes. It is only natural to compare the book with the very similar introductory chapter of Professor Föppl's Einführung in die Maxwell'sche Theorie der Elektricität (1894). In fact the two presentations of vector analysis cover the same number of pages and where Bucherer surpasses in quantity Föppl excels in clearness.

The subjects treated are as usual: scalar and vector products; differentiation with respect to a scalar d/dt and with respect to space by the operator "del," ∇; the properties of the divergence and curl and the combination of them with the line, surface or space integrals to yield the theorems of Gauss, Stokes, and Green. The potential, the equations of Laplace and Poisson, the theorems of Beltrami, of Poincaré and Lorentz, and the principle of Huygens stated in mathematical form close the volume. The applications to physics consist of only the merest fragments of mechanics and hydromechanics. It might have been better to enlarge the work a trifle so as to find room for some slight mention of electricity and magnetism — such as the determination of the Heaviside-Hertz equations of the electromagnetic field. To have taken up the question of the propagation of light in crystalline bodies would have been impossible owing to the complete omission of the elements of the theory of the linear vector function. It may be doubted whether this omission, which deprives the student of perhaps the greatest advantages of the vector notation, is wise.

The treatment of the author may be characterized as formal rather than strictly rigorous—the "physicist's" way of reasoning is employed throughout. For instance, the resolution of a vector into its solenoidal and irrotational parts is worked out without particularly mentioning the fact that such resolution is impossible unless the vector vanishes everywhere at infinity. Such things are, however, not likely to be heeded by those for whom the book is intended.

In selecting a notation the author decides in favor of Heaviside's as modified by Föppl. German letters are used for vectors, Latin for scalars. The scalar product is denoted by juxtaposition of the letters, the vector product by prefixing a a V of unusual font. This question of notation is serious. The most recent German opinion on the subject is by Prandtl in the *Jahresbericht der Mathematiker-Vereinigung* for September. He argues for the adoption of the dot and cross of J. Willard Gibbs with the use of heavy faced type for vectors. The usual objection that in work at the board it is difficult to distinguish between light and heavy type may be met satisfactorily by the use of script for vectors and printed letters for scalars.

On the next page is a table of the notations which the reviewer has seen recently in use or suggested by advocates of vector notations. As a word of explanation it may be stated that only the analytic symbols have been set down. Many persons use the

	Cartesian Equivalent.	Grassmann.	Hamilton and Followers.	Gibbs.	Heaviside.	Föppl, Bucherer.	Henrici.
Scalars.	$a, b, c, \cdots$	Italic.	Italic.	Italic.	Italic.	Italic.	Italic.
Vectors.	$a_x, a_y, a_z,$	Italic.	Greek.	Clarendon.	Clarendon.	German.	Greek.
Scalar Product.	$a_x b_x + a_y b_y + a_z b_z$	$[a \mid b]$	$-S\alpha\beta$	$\mathbf{A}\cdot\mathbf{B}$	$\mathbf{AB}$	$\mathfrak{A}\mathfrak{B}$	$(\alpha\beta)$
Vector Product.	$a_y b_z - a_z b_y, \cdots$	$[ab]$	$V\alpha\beta$	$\mathbf{A}\times\mathbf{B}$	$V\mathbf{AB}$	$\mathbf{V}\mathfrak{A}\mathfrak{B}$	$[\alpha\beta]$
Quaternion Product.			$\alpha\beta$				
Dyad Product.	$a_x b_x, a_x b_y, \cdots$			$\mathbf{AB}$	$\mathbf{A}\cdot\mathbf{B}$		
Gradient of V.	$\frac{\partial V}{\partial x}, \frac{\partial V}{\partial y}, \frac{\partial V}{\partial z}$		∇V	∇V	∇V	∇V	∇V
Divergence of Vector Function $\mathbf{V}$, or $\mathfrak{B}$, or V_x, V_y, V_z or η.	$\frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z}$		$-S\nabla\eta$	$\nabla\cdot\mathbf{V}$		$\nabla\mathfrak{B}$	$(\nabla\eta)$
Curl.	$\frac{\partial V_z}{\partial y} - \frac{\partial V_y}{\partial z}, \cdots$		$V\nabla\eta$	$\nabla\times\mathbf{V}$		$\mathbf{V}\nabla\mathfrak{B}$	$[\nabla\eta]$
Linear Vector Function Operator.	Determinant.		$\varphi\alpha$ Operator inseparable from Operand.	Φ	φ or c		

terms "curl" and "div," which are scarcely to be ranked as symbols. It may be seen that the system of the late Professor Gibbs is perhaps the only one in which the matter of a complete, consistent, and practical notation has been carefully thought out to the end.

E. B. WILSON.

Wissenschaftliche Grundlagen der Elektrotechnik. Von GALILEO FERRARIS. Deutsch herausgegeben von LEO FINZI. Leipzig, B. G. Teubner, 1901. xii + 358 pp.

THE title of this work could not have been better chosen. The lectures on which the book is founded were delivered at the Reale Museo Industrale at Turin and were intended for technical students. Yet the scientific foundations of electric, magnetic, and electromagnetic theory have been placed so emphatically in the foreground and the details of the applications so thoroughly omitted that the work serves also the purpose of an introduction to modern electrical theories. The style is everywhere of the simplest with the emphasis always on the physical conceptions involved. The author begins without assuming on the part of the reader any greater preparation than the elements of the calculus and he builds up carefully, one at a time, the conceptions connected with vectors, electricity, magnetism, and electromagnetism, until at the close of the book he is able to present the elements of Maxwell's theory.

The chief original work of Ferraris was on the magnetic fields arising from the composition of alternating currents of different phases. His memoir entitled "Rotazioni elettrodinamiche," which was published in 1888, is a classic and of value no less for its practical applications to the construction of alternating current motors than for its theory. One might look for an elaborate treatment of this subject in the book before us. As a matter of fact only small mention of it is made, doubtless because the author has in mind the necessity of laying the general foundations rather than of going into details even upon the questions which might interest him most.

The concluding chapter on Maxwell's theory, Hertz's experiments, and Poynting's theorem could have been rendered even more clear by a greater insistence on the notions of curl and divergence; but as it stands it is useful as a guide for those who would follow the theory in its original Cartesian form. The appendix in which are discussed the scientific and practical