method to as few as two hundred and forty individuals, (the number in a study reported by the author). For this reason the generality which he claims by not assuming normality is, for the most part, illusory. Of prime importance among the mathematical problems are those which arise in dealing with sampling variations. These would include the problem of determining optimum estimates of the elements in F, and in actually developing an objective criterion and its probability theory for testing the hypothesis that a set of correlation coefficients can be explained by an F which has been found by any method whatever. Further development of the multiple factor theory will depend largely upon solutions of these problems.

S. S. WILKS

Leçons d'Analyse Vectorielle. By Gustave Juvet. Part II. Paris, Gauthier-Villars, 1935. 306 pp.

This second part of Juvet's *Vector Analysis* contains the applications to mathematical physics. These relate mainly to potential theory, fluid dynamics, and electromagnetic theory. The book contains a good collection of exercises. To provide a basis for the fundamental existence theorems, a brief treatment of Fredholm's theory of linear integral equations is given and an appendix is included which contains the elements of the theory of functions of a complex variable. The mathematical discussions are of intermediate character, making use of conditions of continuity and convergence, but not stressing these matters as much as is customary in works on pure mathematics.

H. B. PHILLIPS

Science and the Human Temperament. By Erwin Schrödinger. New York, W. W. Norton, 1935. 24+192 pp.

Schrödinger writes: "The old links between philosophy and physical science . . . are being more closely renewed. The farther physical science progresses the less can it dispense with philosophical criticism." This book may be regarded as a substantiation of this thesis by means of an illuminating analysis of certain fundamental ideas and issues in contemporary physics.

The most important chapter is entitled *The Fundamental Idea of Wave Mechanics.* It presents the author's theory as a natural development of, and the first theoretical justification for, the similarity between Fermat's principle of minimum time in optics and Hamilton's minimum principle in mechanics. This and the entire previous chapter discuss the role of models in physics.

Two other philosophical issues receive extensive consideration. They are scientific law and causality. The universal reduction of statistical to causal laws is regarded as unjustified. Even the rigorous application of causality in Newtonian mechanics is queried. It required that velocity be determined in defining a state. But velocity was identified with a differential quotient which was defined as $(x_2-x_1)/(t_2-t_1)$ as $t_2-t_1\rightarrow 0$. Hence, the velocity referred "to two units of time and not the state at one moment." Against the coincidence of the two units in the limit, he adds that "possibly this mathematical process of approach to the limit . . . is inadmissible" and "is inadequately adapted to nature" (pp. 61–62).

This suggestion from physics becomes more interesting when we note in pure mathematics that the rigorous formulation of the calculus necessitated assumptions by Dedekind and Cantor which lead to unresolved contradictions. Similar considerations have suggested to this reviewer that the theoretical difficulties at the basis of physics and mathematics may have much more in common than has been realized, and that a clue to their resolution may be found in an alteration in the more general philosophical assumptions common to the two sciences.

F. S. C. NORTHROP

L'Arithmétique dans les Algèbres de Matrices. By Claude Chevalley. (Actualités Scientifiques et Industrielles, No. 323.) Paris, Hermann, 1936. 33 pp.

This book is one of the collection called *Exposés Mathématiques*, published in memory of the late Jacques Herbrand.

This investigation represents another step in the simplification by abstraction of the number theory of linear algebras, a theory which seemed so impossibly complicated when it was first attacked but a few years ago. Ideal theory has grown in importance until, as in the present paper, it constitutes the whole of arithmetic.

Let $\mathfrak{S}$ be a ring with unit element in which every regular element (that is, not a divisor of zero) has an inverse. Then $\mathfrak{S}$ has a regular arithmetic when there is defined a system of modules $\mathfrak{A}, \mathfrak{B}, \cdots, \mathfrak{O}, \cdots$, called ideals such that:

I. The ideals form a groupoid under modular multiplication. The left (right) order of an ideal $\mathfrak{A}$ is the totality $\mathfrak{O}(\mathfrak{O}')$ of elements $\lambda(\lambda')$ such that $\lambda\mathfrak{A}\subset\mathfrak{A}(\mathfrak{A}\lambda'\subset\mathfrak{A})$. The inverse $\mathfrak{A}^{-1}$ of $\mathfrak{A}$ is the set of elements μ such that $\mu\mathfrak{A}\subset\mathfrak{O}'$, $\mathfrak{A}\mu\subset\mathfrak{O}$.

II. If $\mathfrak{A}$ is an ideal, every element of $\mathfrak{S}$ is a product of an element of $\mathfrak{A}$ by the inverse of a regular element of $\mathfrak{A}$.

III. If $\mathfrak{O}$ is a unit of the groupoid, the ideals which have $\mathfrak{O}$ for their left order are the finite left $\mathfrak{O}$-modules which contain regular elements.

IV. In every class of left or right ideals there is an integral ideal prime to any given integral ideal.

The principal result obtained is that if $\mathfrak{S}$ is a total matric algebra over a (not necessarily commutative) field k in which a regular arithmetic is defined, one can define a regular arithmetic in $\mathfrak{S}$. It is known that such a regular arithmetic can be defined in every simple algebra whose centrum is an algebraic field. We see the importance of this result if we recall Wedderburn's theorem that every simple algebra is a total matric algebra over a division algebra.

The above theorem leads to further results in the theory of ideal classes in $\mathfrak{S}$.

C. C. MACDUFFEE

Variationsrechnung und partielle Differentialgleichungen erster Ordnung. By C. Carathéodory. Teubner, Leipzig and Berlin, 1935. 11+ 407 pp.

A century ago Jacobi, influenced by Hamilton's work on geometrical optics, discovered that there exists a direct connection between the theory of the calculus of variations and the theory of partial differential equations of the