The Electromagnetic Field. By Max Mason and Warren Weaver. The University of Chicago Press, 1929. xiii+390 pp.

The object of this book is to give, as far as possible, a mathematically satisfactory treatment of the fundamental facts of electromagnetism. It is divided into four chapters entitled, respectively, Coulomb's Law and Some Analytic Consequences, The Electrostatic Problem for Conductors and Dielectrics, Magnetostatics, The Maxwell Field Equations, which are followed by a mathematical appendix. Each chapter is divided into several parts (each of which is preceded by an introduction telling briefly its object) and is followed by a general conclusion summarizing the results of the chapter. Great attention has been given to the mode of presentation and every serious student of the subject will do well to study the book.

As may be gathered from the title of the first chapter Coulomb's action-at-a-distance formula constitutes the foundation on which the discussion is based so that, philosophically, the authors have not the view-point of Faraday and Maxwell whose efforts were devoted to a replacement of the action-at-a-distance concept by the action-through-a-medium idea. The writer of this review finds himself a follower of Faraday and while admitting the necessity and value of a careful study (such as that given in this book) of the consequences of Coulomb's Law, especially in its statistical aspects, cannot recognize its physical significance. Geometry itself has witnessed the struggle between these two opposing points of view. Euclid was the great proponent of the action-at-a-distance concept while Riemann, actuated precisely by a desire to explain Faraday's results, initiated the study of the infinitesimal action-through-a-medium geometries which has led to the brilliant "connection" theories of Levi-Civita, Weyl, Cartan, and others.

Any endorsement of details on the part of the present reviewer would be presumptuous and so we shall not be misunderstood if we confine ourselves to mentioning the few points where we found it difficult to follow. The essential difficulty in the definition of electric intensity is, as the authors carefully point out, that the introduction of a test-charge modifies the field. The fact that the internal electrostatic energy Ψ_i, of §4 of the book, depends on the position of the test-charge ϵ seems to invalidate the statement that "the portion ψ_ϵ contains all the terms of Ψ which depend upon x_ϵ, y_ϵ, z_ϵ, the co-ordinates of the charge." If this is so the authors are not freed from their own criticism of "basing physical theories on definitions which involve what would happen if an impossible thing were true" (p. 72). The only other point we shall mention is mathematical. The authors first find the expression for the divergence of the electric intensity and then define the electric induction (or displacement) vector in terms of electric intensity and polarization. Now the divergence of a vector is a mathematical concept which derives from Stokes' Theorem on the flux of a vector-field through a closed surface. The electric intensity vector is never integrated through a surface but always along a curve (yielding electric potential) and hence the divergence of electric intensity has no real physical meaning while the divergence of the electric induction vector has, since the characteristic property of this vector-field is that its integral over any closed surface gives the charge enclosed by the surface.

F. D. MURNAGHAN