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★**Electromagnetism and the structure of matter.**

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This monograph generalizes classical electrodynamics by modifying the vacuum Maxwell equations (expressed in differential form). Specifically, two modifications are made. First, a nonlinear term is added to Ampère's Law. This correction resembles that of the presence of moving charges. Secondly, Coulomb's Law is eliminated, which means that an electric field in vacuo may possess a nontrivial divergence (despite the absence of electric sources). As this divergence approaches zero, as in macroscopic phenomena such as far-field antenna radiation, we recover the four Maxwell equations.

The corrections are motivated by geometric optics, in particular, the goal of finding a system of equations consistent with classical theory that admits spherical wavefront solutions and soliton solutions. The modified equations can be derived from a variational principle in which the conventional Maxwell Lagrangian action is varied on a constraint surface that enforces the principles of geometric optics (in the words of the author, "the germ of the Huygens principle" [p. 38]).

Consequences of this modified electrodynamics are numerous. The continuity equation and conservation of energy follow from the equations, and the equations are invariant under Lorentz transformations. In this theory the constancy of the speed of light is equivalent to the eikonal equations (for geometric development of wavefronts) being satisfied. Consequent "solitary wave equations" are compatible with quantum electrodynamics (QED) in the sense that when they are combined with model equations for energy quantization (for example, the Klein-Gordon, Pauli, or Dirac equations), QED may be derived. This distinguishes the theory at hand from other nonlinear electrodynamic theories, such as the Born-Infeld theory.

The author next examines the interaction of the solution waves with matter. The model may be further generalized to allow waves along curved trajectories in order to simulate phenomena where light is perturbed from its natural path, in analogy to the flows of a fluid evolving via the non-viscous Euler equation.

The Lorentz invariance of the modified equations encodes the first and second postulates of special relativity, and the Maxwell stress tensor alone (in the absence of matter) and the Maxwell stress tensor added to the mass tensor (in the presence of matter) substituted into Einstein's equations yield the model equations, thus demonstrating consistency with relativity theory. More speculatively, the book concludes with the case of two-dimensional waves turning around an axis. The extension to three dimensions leads to a deterministic model of stable elementary particles and hints at a causal explanation of quantum-mechanical phenomenology.

Reviewed by *Jeffrey K. Lawson*