Review of: "Can the electromagnetic fields form tensors if D = ϵE and H = B/μ?"

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This paper examines the Abraham-Minkowski controversy using a simple covariant formulation. The “controversy” arises in the analysis of the interaction between electromagnetic field and matter. The constitutive laws may assume different forms depending on how the field-matter interaction is modeled, as shown for example in the monograph By P. Penfield and H. A. Haus – Electrodynamics of Moving Media (1967). A short account of this subject is given by C. T. Tai, “Present Views on Electrodynamics of Moving Media”, Radio Science, Vol.2, No. 2, 1967. Presently, the prevailing understanding is that only the total stress-energy tensor, combining both field and matter contributions, has clear physical significance.

The paper constructs a stress-energy tensor using the same steps used in the free-space formulation, including the contributions of both free electric charge and current densities. The contribution of polarization-magnetization components is introduced via permittivity and permeability parameters. The Maxwell source equations written in terms of the potentials (equations 21 and 22) are correct for constant permittivity-permeability. However, to properly consider the interaction with matter, it would be necessary to establish an equation of motion for the polarization-magnetization charges in terms of the potentials (or to construct a model for the permittivity and permeability in terms of the potentials). The problem arises with the application of the Lorentz gauge assuming constant parameters. The wave equations 23 and 24 correspond to the radiation zone in the vacuum region exterior to the free charges (the free charges may be embedded in the field). In this case the propagation velocity is the velocity of light and the stress-energy tensor is correct. If the effect of the electromagnetic field upon the free charges is considered, it is still necessary to establish an equation of motion for the true charges in terms of the fields and construct a consistent model.

I think that the paper is interesting, but the conclusions must be reformulated. The electromagnetic fields can be combined in relativistic tensors, including polarization-magnetization components, if the field-matter interaction is properly considered.