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The Constitutive Relations and the Magnetoelectric Effect for Moving Media

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In this paper the constitutive relations for moving media with homogeneous and isotropic electric and magnetic properties are presented as the connections between the generalized magnetization-polarization bivector $%\mathcal{M}$ and the electromagnetic field F. Using the decompositions of F and $\mathcal{M}$, it is shown how the polarization vector P(x) and the magnetization vector M(x) depend on E, B and two different velocity vectors, u - the bulk velocity vector of the medium, and v - the velocity vector of the observers who measure E and B fields. These constitutive relations with four-dimensional geometric quantities, which correctly transform under the Lorentz transformations (LT), are compared with Minkowski's constitutive relations with the 3-vectors and several essential differences are pointed out. They are caused by the fact that, contrary to the general opinion, the usual transformations of the 3-vectors $% \mathbf{E}$, $\mathbf{B}$, $\mathbf{P}$, $\mathbf{M}$, etc. are not the LT. The physical explanation is presented for the existence of the magnetoelectric effect in moving media that essentially differs from the traditional one.

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