IRREVERSIBLE THERMODYNAMICS OF THE ELECTROMAGNETIC CONTINUUM WITH SPIN

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In the framework of irreversible thermodynamics an electromagnetic (EM) continuum with spin is described. The entropy production, generalised thermodynamic fluxes and their conjugate forces are calculated. The constitutive equations for the thermodynamic variables enclosing magnetisation and symmetry relations for kinetic coefficients are written. The balance equations for internal energy, impulse and spin are obtained employing conservation of total energy, impulse and spin with mechanical and EM field terms. An additional spatial and surface force and force moments determined by EM vector potential $\mathbf{A}$ appear due to EM field and spin $\mathbf{s}$ ($\mathbf{s}=\theta\boldsymbol{\omega}$, $\boldsymbol{\omega}$ is the internal rotation velocity) interaction. Without Lorentz gauge the spatial force $\mathbf{f}^A=z^E\mathbf{E}^{\mathbf{A}}+(\mathbf{D}\nabla)\mathbf{E}^{\mathbf{A}}$ and force moment $\mathbf{N}^{\mathbf{A}}=z^A\mathbf{H}\text{-}c^{-1}[\mathbf{J}^A\mathbf{E}''] +(4\pi)^{-1}A_n\nabla H_n+[\mathbf{J}^E\mathbf{A}/c]$, where z^E and z^A are the electrical and "spin" charges, $\mathbf{D}$ and $\mathbf{H}$ are the inductions, $\mathbf{E}^A=[\boldsymbol{\omega}\mathbf{A}/c]$ is the effective electrical field, $\mathbf{J}^{\mathbf{A}}$ is the flux of z^A, $\mathbf{J}^E$ and $\mathbf{E}''$ are the effective electric current and field.

the Category: 6
the preference: poster
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