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Poynting vector in magnetic materials: from thermomagnetic effects to metamaterials ANDREI SERGEEV, MICHAEL REIZER, VLADIMIR MITIN, SUNY at Buffalo — In a finite sample, besides the bulk currents given by the Kubo formula, additional charge and energy are transferred by surface magnetization currents. We show that for the energy current, the corresponding surface correction to the Kubo's current is expressed in terms of the magnetization component of the Poynting vector, MxE. Magnetization currents, like persistent currents, are dissipationless and do not transfer entropy. Only in this way, one can obtain the Nernst and Ettingshausen coefficients that satisfy to the Onsager relation. In the microscopic transport theory, for maintaining gauge invariance in a magnetic field, the heat current operator should include the magnetic term. Both magnetization-related effects - the dissipationless nature and strong surface contribution to the energy transfer - have been also overlooked in the recent works on the Poynting vector in metamaterials. The paradoxes in this area are resolved, if one accurately considers a balance of electromagnetic energy transferred by bulk and surface magnetization currents.

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