Abstract

A New Method of Homogenization of the Maxwell Equations

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A new method of homogenization of the Maxwell equations is proposed. This method is based on newly proved mathematical lemma that any vector field can be presented as a sum of its "electrical dipole", "electrical quadrupole" and "magnetic dipole" moments. The responding "moments" have a well-known form of the common moments as if the vector field is a current density. This presentation of the vector field is exact and connects neither to multipole expansion nor to the Helmholtz theorem. This lemma permits consequently introduce a concept of magnetic permeability at high frequencies even in the case of impermeable ingredients. The deduced renormalization group equations result in effective fields, which are governed by the usual material Maxwell equations, but differ from the mean values of the same-named fields. As illustrations of the method are presented (1) the derivation of the known EMA formula that takes into account the skin effect, this derivation emphasizes the role of anapole moment of currents, (2) consideration of the properties of q-media (media where the quadrupole interaction of fields with matter is prevalent) are considered.