

Handedness in plasmonics: electrical engineer's perspective

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Abstract-This presentation focuses on the concept of handedness in complex media and metamaterials. Is it a property of the medium or the wave?

Geometry and matter are intimately connected. This fact manifests itself very clearly in the study of the interaction of electromagnetic waves with materials, and especially in the case of complex media, like bianisotropic materials and metamaterials [1]. Geometry in the structure of matter may break the symmetry of the material response with the result that the characterization of the material relations have to be more general than those for simple isotropic materials. "*C'est la dissymétrie qui crée le phénomène,*" declares Pierre Curie (1894) in connection with his studies on piezoelectricity and paramagnetism.

The studies on chiral, or handed materials have emphasized another manifestation of material-geometric effects in the electromagnetic medium response. If the structure of a medium breaks the parity (it is different from its mirror image) it will display magnetoelectricity: an electric field will cause magnetic polarization and vice versa. Observational effects due to chirality are the optical activity (rotation of the polarization of the plane of the wave) and circular dichroism [2].

Another medium property that bears connection with handedness has entered into the scientific discussion in recent years: the strange properties of so-called double-negative media. These materials, also known as Veselago materials [3], have the property that the electric field, magnetic field, and wave vector of the propagating linearly polarized wave form a left-handed triplet, unlike in the "ordinary," positive-material-parameter media. The fact that handedness is connected to the orientation and state of field vectors instead of the real structural geometry of the medium has caused many misunderstandings in recent discussions. The talk will discuss these two different and independent concepts of handedness as well as other cultural and terminological disharmonies between the electrical engineering community on one hand, and that of the material physics on the other.

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