Highlights

Other Materials - 2015

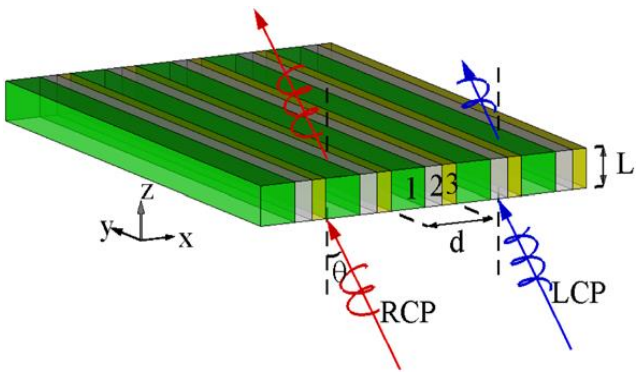
One-Dimensional Chirality: Strong Optical Activity in Epsilon-Near-Zero Metamaterials

Carlo Rizza[1,2], Andrea Di Falco[3], Michael Scalora[4], and Alessandro Ciattoni[2]

[1]Dipartimento di Scienza e Alta Tecnologia, Università dell'Insubria, Via Valleggio 11, 22100 Como, Italy
[2]Consiglio Nazionale delle Ricerche, CNR-SPIN, Via Vetoio 10, 67100 L'Aquila, Italy
[3]School of Physics and Astronomy, University of St. Andrews, North Haugh, St. Andrews KY16 9SS, United Kingdom
[4]Charles M. Bowden Research Center RDMR-WDS-WO, RDECOM, Redstone Arsenal, Alabama 35898-5000, USA

PHYSICAL REVIEW LETTERS 115, 057401 (2015)

We suggest that electromagnetic chirality, generally displayed by 3D or 2D complex chiral structures, can occur in 1D patterned composites whose components are achiral. This feature is highly unexpected in a 1D system which is geometrically achiral since its mirror image can always be superposed onto it by a 180 deg rotation. We analytically evaluate from first principles the bianisotropic response of multilayered metamaterials and we show that the chiral tensor is not vanishing if the system is geometrically one-dimensional chiral; i.e., its mirror image cannot be superposed onto it by using translations without resorting to rotations. As a signature of 1D chirality, we show that 1D chiral metamaterials support optical activity and we prove that this phenomenon undergoes a dramatic nonresonant enhancement in the epsilon-near-zero regime where the magnetoelectric coupling can become dominant in the constitutive relations.



Sketch of metamaterial slab (with N = 3 layers) and waves scattering geometry. The transmission amplitudes of the right-handed (RCP;+) and left-handed (LCP;−) circular polarized plane waves are not equal for $\theta \neq 0$ as manifestation of 1D chirality.