Metamaterials Incorporating “Smart” Elements: Gyromagnetism in the Absence of a Magnetic Field

Technology #15022

Applications

Devices using gyrotropic metamaterials, such as optical isolators and circulators, play critical roles in optical communication and computing technologies due to their ability to eliminate cross-talk and feedback.

Problem Addressed

Electromagnetic materials lacking local time-reversal symmetry, such as gyrotropic materials, are of keen interest and importance technologically. However, most natural materials that lack local time-reversal symmetry require strong external fields, and function only in a limited range of the electromagnetic spectrum. Ferromagnetic resonance requires lower intensity external fields, but is limited to the GHz frequency range. Magnetized plasma and Zeeman splitting of optical diode transitions provide gyrotropy at optical frequencies -albeit, at a weak level with high biasing fields. These constraints, together with associated large absorption peaks, have so far prevented large-scale application of nonreciprocal photonic systems. However, the advent of photonic crystals and metamaterials enabled synthesis of artificial composite materials, possessing previously nonexistent electromagnetic properties, such as negative indices of refraction.

Technology

The gyrotropic metamaterial structure includes chiral metamaterials, configured to form pairs of dipole structures. Lumped circuits with antennas are placed between the dipoles to change the polarization states of an incident polarized wave. This is done by producing Faraday-like rotation allowing for nonreciprocal propagation of the incident polarized wave. The lumped circuits comprise a structure that amplifies the power received by the incident polarized wave. In this way, the device uses metamaterials of “global” properties that display novel behavior for electromagnetic radiation of wavelengths longer than the size of each meta-material element, and the size of the spacing between the elements. This gyromagnetic power amplification is scalable to other wavelengths, and grants the opportunity to synthesize exotic electromagnetic materials.

Advantages

- Eliminates cross-talk and feedback in optical communication and computing technologies
- Allows for reflection-free transport over large bandwidths in the presence of large disorder without large bias fields
- Scalable to a variety of optical wavelengths

Categories For This Invention:

255 Main Street, room NE 18-501
Cambridge, MA 02142-1601
Phone: 617-253-6966 Fax: 617-258-6790
http://tlo.mit.edu
Contact the Technology Manager: tlo-inquiries@mit.edu

Computer Sciences & Information Technology
Signal Processing
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Gyrotropic metamaterial structure
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Inventors:

John Joannopoulos
Marin Soljacic
Zheng Wang
Zhiyu Wang
Lixin Ran

Publications:

Gyrotropic response in the absence of a bias field
Proceedings of the National Academy of Sciences of the United States of America
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External Links:

Group Link
http://www.rle.mit.edu/marin/

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255 Main Street, room NE 18-501
Cambridge, MA 02142-1601
Phone: 617-253-6966 Fax: 617-258-6790
http://tlo.mit.edu
Contact the Technology Manager: tlo-inquiries@mit.edu