EOP Doctoral Defense

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SC 128 at 1:00 PM

All are welcome to attend.

Directional emission of light in hyperbolic metamaterials and its application in miniature polarimeter

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Abstract

Metamaterials are artificial media engineered to have the unusual electromagnetic (EM) properties that are not found in nature. We demonstrate a dipole with circular polarization located in the vicinity of a metamaterial with a hyperbolic dispersion relation in two dimensions. The EM waves will be guided into two different directions dependent on the polarizations of the incident illumination. Actually, this phenomenon can be called photonic spin-Hall effect. Photonic spin-Hall effect can be significantly magnified in a curved hyperbolic metamaterial (or called hyperlens).

First of all, an overview of hyperbolic metamaterials and some details of the finite element analysis are briefly given. In the second part, we theoretically and numerically investigated the magnification of the photonic spin-Hall effect from a single dipole emitter. Through studying the dispersion of the curved hyperbolic metamaterial, a maximum half angular separation of 45.0◦ between the right-handed circular and left-handed circular polarization channels can be obtained. Moreover, the curved hyperbolic metamaterial can provide a complete separation of the spin dependent radiation channels. It is crucial to control the photonic emission by single emitters in nanophotonic systems for quantum information processing. The presented work of spin dependent directional emission introduces a new route to steer the direction of the electromagnetic waves, which also provides a great opportunity for compact polarization-tunable unidirectional manipulation of EM waves and nano-particles, especially in on-chip integration.

In the end, a novel application in polarization detections of miniature Stokes polarimeter, realized by hyperbolic metamaterials with two dipoles at two azimuthal orthogonal positions, is proposed. Through measuring the intensities of the two radiation channels of each dipole, any polarization can be analyzed. Both the parallel and crossed emission channels promise excellent accuracy, which makes the working bandwidth broader. This compact design would be a fantastic candidate for high spatial resolution polarization sensor and imager for a broad array of application