The Non-trivial States Excited by Bianisotropic Metamaterials

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Abstract— In electromagnetic, the solution of Maxwell Equations is commonly trivial. In this talk, we present our recent work on exciting the non-trivial states in electromagnetic, i.e., combining the two trivial eigen-states through the bianisotropy of the metamaterial. We show the definition of the spin-up and spin-down states, and their connection through time reversal symmetry. With our theoretical work, the symmetry requirement for the material's constitutive parameters is no longer the sufficient condition in exciting the non-trivial states.

The electrodynamics in source free region can be described by Maxwell Equations, which reads

$$\nabla \times \bar{E} = i\omega\bar{B}, \tag{1}$$
$$\nabla \times \bar{H} = -i\omega\bar{D}, \tag{2}$$

With $\bar{D} = \bar{\bar{\varepsilon}} \cdot \bar{E} + \bar{\bar{\tau}} \cdot \bar{H}$, $\bar{B} = \bar{\bar{\mu}} \cdot \bar{H} + \bar{\bar{\kappa}} \cdot \bar{E}$. The choice of $\bar{\bar{\varepsilon}}$, $\bar{\bar{\mu}}$, $\bar{\bar{\tau}}$ and $\bar{\bar{\kappa}}$ should satisfy the lossless and the reciprocal conditions: $\bar{\bar{\varepsilon}} = \bar{\bar{\varepsilon}}^{+} = \bar{\bar{\varepsilon}}^{T}$, $\bar{\bar{\mu}} = \bar{\bar{\mu}}^{+} = \bar{\bar{\mu}}^{T}$, $\bar{\bar{\kappa}} = \bar{\bar{\tau}}^{+} = -\bar{\bar{\tau}}^{T}$. If the metamaterial is made of double SRR structure, shown in Fig. 1. The effective parameters are $\bar{\bar{\varepsilon}} = \mathrm{diag}[\varepsilon_1, \varepsilon_1, \varepsilon_2]$, $\bar{\bar{\mu}} = \mathrm{diag}[\mu_1, \mu_1, \mu_2]$ and $\bar{\bar{\kappa}} = \bar{\bar{\tau}} = \begin{bmatrix} 0 & \tau & 0 \\ -\tau & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$. The pseudo-spin can be defined for those bond states, i.e., $\partial_y \psi^{\pm} = \pm\gamma\partial_x\psi^{\pm}$.

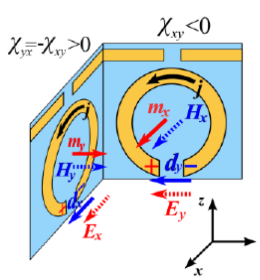

Figure 1: The double SRR unit cell proposed in Ref. [1].

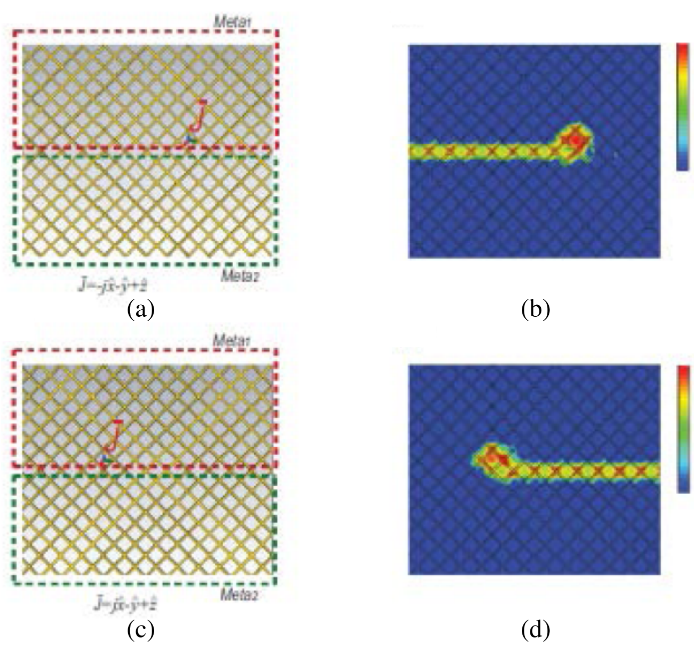

Figure 2: The excitation of the spin-up and spin-down states.

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REFERENCES

1. Khanikaev, A. B., et al., "Photonic topological insulators," *Nature Materials*, Vol. 3520, 233–239, 2013.