Trapped-Mode Resonances in Isotropic Planar Metamaterials

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Abstract— We propose a new type of planar metamaterials that can support high-Q electromagnetic modes, namely trapped modes, excitation of which is *polarization insensitive*.

Achieving resonances with high-Q factors is essential for various applications of planar metamaterials. Recently we demonstrated both theoretically [1] and experimentally [2] that exceptionally strong and narrow resonances are possible in planar metamaterials if certain small asymmetries are introduced in the shape of their structural elements. Appearance of the resonances was attributed to the excitation of otherwise inaccessible anti-symmetric current modes, i.e. "trapped modes", through polarization dependant weak free-space coupling provided by the symmetry breaking.

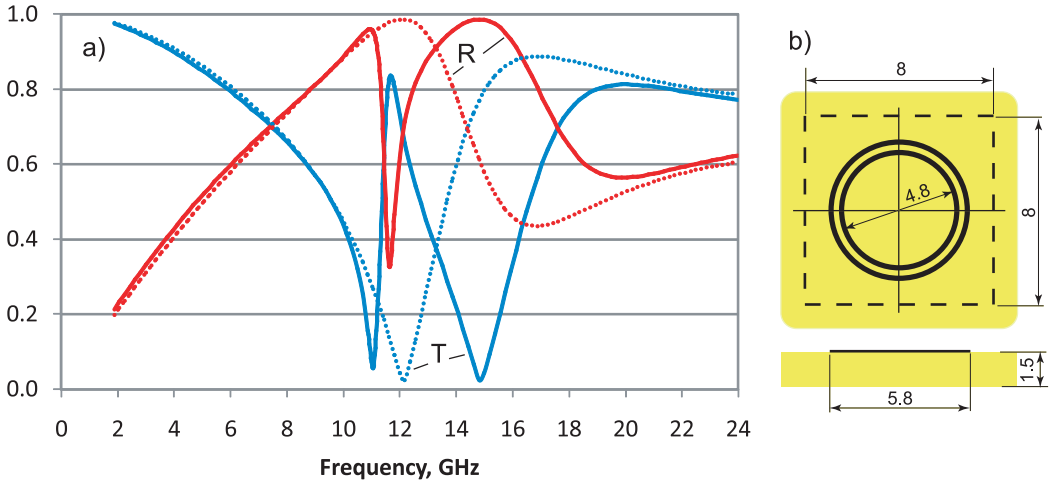

Figure 1: (a) Absolute values of transmission and reflection coefficients. Solid lines correspond to an array of double-ring particles, while dashed lines are obtained for single rings. (b) A unit cell of the metamaterial, which is a square array of double rings supported by a dielectric substrate with $\epsilon = 4.07 - i0.05$.

Here we identify a new class of planar metamaterials that can support trapped modes. Remarkably, achieving sharp high-Q resonances in such metamaterials requires no symmetry breaking and therefore excitation of trapped modes is *polarization insensitive*. The proposed metamaterials are isotropic and formed by a square planar arrays of metallic highly symmetric complex particles such as, for example, a pair of concentric rings (see Fig. 1b). As Fig. 1a shows, such double-ring metamaterial exhibits a very sharp transmission resonance near 11.6 GHz, as opposite to the reference single-ring structure.

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REFERENCES

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