

Huygens scatterer based on two uncoupled SRRs

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Huygens sources inspired on metamaterial resonators have attracted much attention because of their use in electrically small antennas (P. Jin and R. W. Ziolkowski, *IEEE Antennas Wirel. Propag. Lett.*, 9, 501-505, 2010) and Huygens metasurfaces (C. Pfeiffer and A. Grbic, *Phys. Rev. Lett.*, 110, 197401, 2013). An ideal Huygens source is achieved by combining an electric dipole with a magnetic dipole of equal strength, in phase, and orthogonal. Initially, it was approximately achieved by using two different metallic particles, each one providing one dipole. Recently, a Huygens metasurface based on the element shown in Fig. 1(a) was proposed (M. Londoño et al., *Phys. Rev. Appl.*, 10, 034026, 2018). It is made of two planar split ring resonators (SRR) mounted with inversion symmetry and laterally shifted to avoid any electromagnetic coupling. In such a way, the electric and magnetic resonant modes are degenerated in frequency.

In this work, we have numerically studied the scattering by the element of Fig. 1(a). It is made of perfect electric conductor and the geometrical parameters are: $R = 1.7$ mm, $g = 0.2$ mm, $w = 0.2$ mm, $l = 2.65$ mm, $s = 2.53$ mm, and $h = 0.5$ mm. Using the method published in (J. L. Araque and J. D. Baena, *Proc. Metamaterials*, 490-492, 2013), in which the element is illuminated with six linearly independent plane waves, we have retrieved all components of the polarizability tensor. Only the strong components of the polarizability tensor are depicted in Fig. 1(b). According to the expected for a Huygens scatterer, the electric polarizability, α^{ee}_{yy} , and the magnetic polarizability, α^{mm}_{zz} , resonate at the same frequency and have very similar curves. Additionally, the bistatic RCS at the resonance frequency is shown in Fig. 1(c), which resembles the shape expected for an ideal Huygens source. It corresponds with an incident plane wave travelling along the x -axis and with fields properly oriented to excite both the magnetic and electric dipoles.

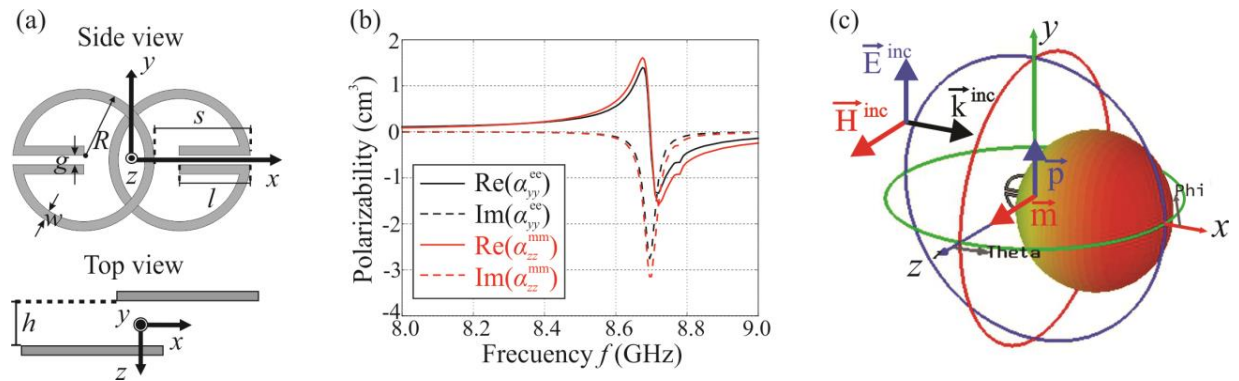


Figure 1. Geometry (a), polarizabilities (b), and bistatic RCS (c) of the Huygens' source.