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Co-circular polarization reflector revisited

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It is known that a circularly polarized wave, when reflecting from a perfect electric conductor, changes its handedness. This may or may not be desirable, and much effort has been expended in design of surfaces for which this reversal of handedness could be avoided. One interesting design which has been recently introduced is based on anisotropic surface impedance [1], and is shown to work as perfect co-polarization reflector with a wide angular range. In [1], also a metamaterial realization for such a surface has been given.

Here we put this surface into a framework of general electromagnetic boundary conditions. Boundary conditions can be classified in several ways. The perfect electric and perfect magnetic conductors (PEC and PMC) are idealizations but very well known and much used concepts in antenna design and microwave engineering. Other examples include the Soft-and-hard surface (SHS), which is an example of anisotropic surfaces. The impedance boundary condition forms a very general class and will be discussed in this presentation. Other fundamental ones are so-called DB and D'B' boundaries in which the condition works for the normal components of the fields, rather than their tangential components. For a systematic discussion on the variety of electromagnetic boundary conditions, see the recent monograph [2].

In the talk, the focus is on particular properties of the co-polarized circular reflector. It can be defined by writing its anisotropic surface impedance

$$\mathbf{E}_t = \overline{\overline{\mathsf{Z}}}_s \cdot (\mathbf{n} \times \mathbf{H}_t) \tag{1}$$

between the tangential electric and magnetic fields at the boundary: $\mathbf{E}_t = -\mathbf{n} \times (\mathbf{n} \times \mathbf{E})$ and $\mathbf{H}_t = -\mathbf{n} \times (\mathbf{n} \times \mathbf{H})$, (and $\mathbf{n}$ is the unit normal of the surface). Here the surface impedance dyadic is

$$\overline{\overline{\mathsf{Z}}}_s = -\mathrm{j}\eta_0 \sinh(u)\, \overline{\overline{\mathsf{I}}}_t + \mathrm{j}\eta_0 \cosh(u)\, \overline{\overline{\mathsf{L}}} \tag{2}$$

where the two base dyadics are $\overline{\overline{\mathsf{I}}}_t = \mathbf{vv} + \mathbf{ww}$ and $\overline{\overline{\mathsf{L}}} = \mathbf{vw} + \mathbf{wv}$, with the tangential unit vectors $\mathbf{v}$ and $\mathbf{w}$. In the talk, the reflection characteristics of this surface are analyzed as well as the possibilities of supporting *matched waves* on this boundary.

References

[1] F. Liu, S. Xiao, A. Sihvola, and J. Li, "Perfect co-circular polarization reflector: A class of reciprocal perfect conductors with total co-circular polarization reflector," *IEEE Transactions on Antennas and Propagation*, **62**, 12, pp. 6274–6281, 2014.

[2] I. V. Lindell and A. Sihvola: *Boundary Conditions in Electromagnetics*. IEEE Press, Wiley, Hoboken, NJ, USA, 2020.