Exact Geometrical Optics Scattering by a Class of Metallic Wedges Under Multiple Plane Waves Illumination

Piergiorgio L. E. Uslenghi
Department of Electrical and Computer Engineering
University of Illinois at Chicago, USA
uslenghi@uic.edu

The only single wedge for which an exact geometrical optics solution under single plane wave incidence is known is a wedge with aperture angle of 90° made of DNG metamaterial (P.L.E. Uslenghi, "Exact geometrical optics scattering by a right-angle wedge made of double-negative material", *IEEE Trans. Antennas Propag.*, vol. 54, pp. 2301-2304, Aug. 2006). If the wedge is a perfect electric conductor (PEC) and the incident field is a single plane wave, geometrical optics cannot provide the exact solution to the scattering problem. However, it is sometimes possible to obtain an exact geometrical optics solution if more than one plane waves are incident on the wedge, provided that the boundary conditions are satisfied, that no field discontinuities occur across optical boundaries and that the phase, polarization and direction of incidence of the primary waves are chosen in such a way as not to excite the edge of the wedge. In such cases, the exact total field everywhere in the medium surrounding the wedge consists of the superposition of standing plane waves. Two such configurations have been described recently: a 90° metal wedge on which three plane waves are incident (P.L.E. Uslenghi, "Exact geometrical optics scattering by a right-angle metallic wedge illuminated by three plane waves", *Digest of USNC-URSI National Radio Science Meeting*, Boulder, CO, Jan. 2019), and a 45° metal wedge on which seven plane waves are incident (P.L.E. Uslenghi, "Exact geometrical optics scattering by a 45° metal wedge illuminated by multiple plane waves", *Proc. URSI Electromagnetic Theory Symposium (EMTS 2019)*, San Diego, CA, May 2019).
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In the present work, a metallic wedge whose aperture angle α is an even sub-multiple of π radian, i.e. $\alpha = \pi/(2n)$ where n is a positive integer, is considered. It is shown that a sufficient condition to have geometrical optics as the exact solution is that there be $4n - 1$ plane waves incident on the wedge. The phase and direction of incidence of the primary waves are specified for both E- and H-polarizations. The previous results obtained by the author are particular cases of the general formulas derived herein. As an additional example, the particular case of a 30° wedge (corresponding to $n = 3$) illuminated by eleven plane waves is studied in detail. The analysis is conducted in the phasor domain with the time-dependence factor $exp(+j\omega t)$ omitted throughout.