Fast Analysis of Impedance Surface Reflector Antennas via the Applications of Gaussian Beam Expansions

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Impedance surfaces are employed in the design of reflector antennas in many applications such as being subreflectors in dual reflector configurations, which can be used in frequency selected manners. With the increasing trend of applications in the high frequency, the analysis of radiation from such an antenna system becomes computational inefficient if the conventional approach of physical optics (PO) is employed. Note that PO requires cumbersome numerical integration over the induced currents on the boundaries of the reflector surfaces, and is very inefficient at high frequencies. This paper extends previous work of Gaussian beam (GB) applications in the fast analysis of perfectly conducting reflector antennas (H-T Chou, P.H. Pathak and R.J. Burkholder, IEEE Trans. Antenna Propa., 49(6), pp. 880-893, Jun. 2001) to treat the impedance surface reflector antennas. The GB techniques represent the feed radiations in terms of a set of relatively few and rotationally symmetric GB's that are launched from the phase center of feed and illuminate the reflector surfaces. PO is then employed to treat the scattering of each GB illumination. The advantages of the GB techniques are that closed form solutions based on asymptotic evaluation of PO integral due to each GB incidence can be found in terms of reflection and edge diffraction effects with a transition function in terms of complex parameters, and in most cases only a relatively few GB's are sufficient to provide accurate prediction of radiating fields. Note that the complex parameters completely avoid the ray caustic problems in real space, and since numerical integrations are completely avoided, the efficiency can be therefore achieved. Numerical implementation and examination will be presented to validate the extended GB techniques in terms of accuracy and efficiency.