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Uniform Theory for Complex Source Pulsed Pulsed Beam (CSPB) Diffraction by a Wedge: A Spectral Theory of Transient (STT) Solution

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The complex source pulsed beams (CSPB) are exact, highly-collimated, space-time-wavepacket solutions of the time-dependent (or Maxwell) equation that are modeled as radiation from pulsed sources located at complex space-time points [1]. The properties of the resulting wave field, namely their direction and collimation, are fully determined by the complex-source coordinates. It should be noted though that the complex source model is only a trick to derive mathematically compact expressions for the field: Physically, the CSPB is generated by a *real*, time-dependent source distribution over a *finite* aperture [2].

An important application of the CSPBs is their use for local interrogation of the propagation environment. By aiming the CSPB at specific regions and directions, one may selectively excite and explore the local wave phenomena associated with that region. A closed-form solution for the scattered field can then be derived via the spectral theory of transient (STT), as had been done for the scattering of a 3D-CSPB at a dielectric interface, including local excitation of head waves [3], and 3D-CSPB diffraction by a wedge [4,5].

The expression for the CSPB diffraction in [4,5] has been derived by applying the STT onto the exact spectral solution for a *real*-time-harmonic point source [6; Chapter 6.5], extended to the *complex* source case. Paper [4] derives the exact solution, wherein the physical properties of the problem are included implicitly, whereas [5] derived explicit local scattering models for the diffraction mechanism in terms of the CSPB collimation properties, its direction, and its displacement from the wedge axis. This solution is uniform with respect to the distance between the beam axis and the wedge axis, and also with respect to the shadow and reflection boundaries.

The goal of the present paper is to rederive the local scattering models of [5] by using the uniform theory of diffraction (UAT) formulation of the problem. To this end, we extend the UAT solution for a *real*-time-harmonic point source [7] to the complex source case (see also [8]. Then, to transform the result into the pulsed beam (PB) case, we re-express this UAT solution as a spectral integral and then apply the STT procedure of [4]. The resulting expression contains many complex-space constituents, but when interpreted correctly, the final result agrees with the local scattering models of [5].

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