Spectral Solution for EM Fields in Locally-Tilted, Planar-Stratified Media with Arbitrary Anisotropic and Lossy Layers

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We discuss a full-wave numerical technique, based upon a 2-D integral spectral expansion, to model the interaction of electromagnetic (EM) waves with arbitrary anisotropic and lossy media that possess (locally) planar interfaces (effectively) tilted relative to each other.

Layered medium structures are routinely analyzed due to their (locally) approximating to first order the dominant inhomogeneity features encountered in many problems of interest (atmospheric EM wave propagation, airborne and subsurface remote sensing, microwave circuit and antenna operation, etc.). However, relatively little attention has been paid to EM wave behavior within media that (locally) are layered but with interfaces tilted relative to each other, despite their importance in many applications such as in propagation in inhomogeneous subterranean media [G. A. Schlak and J. R. Wait, *Can. J. Phys*., vol. 45, no. 11, 1967] and optical propagation through tilted refractive lenses [S. Zhang et al., *Proc. SPIE*, vol. 8550, 2013).

Some challenges of this problem are (i) full-wave modeling of these *local* interactions, (ii) ensuring that the computed solution *globally* exhibits compatibility with the radiation condition, and (iii) *flexibly* overcoming the former two difficulties for arbitrary anisotropic and lossy media. In the past, solutions of this problem sacrificed the full-wave nature of the computed solution (i.e., they were applicable only in the high-frequency regime) and placed severe restrictions on the media that could be modeled (isotropic, and either extremely lossy or lossless, as in the references above).

Our methodology is based upon coating each of *N*-1 interfaces with media specially-designed via Transformation Optics (T.O.). This causes the *N*-1 coated, flat interfaces to interact with EM waves *as if* said interfaces were in fact tilted, with the effective tilting unequivocally determined by the easily-defined properties of the coating slabs. Moreover, the T.O. slabs are also readily adaptable to the anisotropy and loss of the *N* layers and place no added stipulation on the frequency regime of the radiated fields being modeled.

We present numerical results related to subsurface geophysics and investigate the effect of the local tilting on the sensor's observables.