Robust and Efficient Pseudo-Analytical Computation of Fields from Arbitrarily-Oriented Dipoles in General Doubly-Anisotropic, Planar-Stratified Environments

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We develop an efficient and general purpose formulation, based on two-dimensional inverse Fourier-type integrals, for computing fields produced by arbitrarily-oriented dipoles in planar-stratified environments. Each layer may exhibit *arbitrary and independent anisotropy and loss* in both the complex permeability *and* the complex permittivity. Among the salient features of our formulation are (*i*) computation of eigenmodes (i.e. characteristic plane waves), supported in arbitrarily anisotropic media, in a numerically robust fashion, (*ii*) implementation of an *hp*-adaptive integration refinement scheme for numerically evaluating the radiation and weakly-evanescent spectral field contributions, and (*iii*) development of an adaptive extension to a well-known, potent integral convergence acceleration technique to rapidly and efficiently compute the strongly-evanescent spectrum's field contribution. Other semi-analytic techniques exist to solve this problem, such as the numerical evaluation of Fourier-Hankel and Fourier-Bessel integral transforms. However, none of these techniques have general applicability to media exhibiting arbitrary double-anisotropy in each layer, where one must account for the full range of possible phenomena such as mode coupling at the planar interfaces and non-reciprocal mode propagation. Furthermore, brute-force numerical methods can tackle this problem as well but only at a considerably higher computational cost. The present formulation thus provides both an efficient *and* general purpose methodology to effect accurate field computations in planar-stratified environments containing arbitrary combinations of anisotropic and lossy media. We demonstrate the formulation's efficacy to handle anisotropic and conductive media over a wide range of source-observer separation configurations via its application to analyzing response characteristics of induction sensors employed in subsurface geophysical exploration.