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On Recent Findings in the Theory of Complex Waves in Open Metal-Dielectric Waveguides

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Theory of complex waves (see e.g. [1] and references therein) accumulated a big volume of results. However, its biggest drawback remains which brakes significantly the development of the theory: absence of rigorous proofs of the existence of complex waves. In this respect, studies of complex waves in open metal-dielectric waveguides has been essentially enhanced when two new families of symmetric (angle-independent) complex waves have been identified [2, 3] in a dielectric rod (DR) and Goubau line (GL) with homogeneous dielectric cover: surface complex waves occurring as perturbations of real surface waves caused by the presence of lossy dielectric, and pure complex waves which have no counterpart in the set of real waves. Existence of the latter family of complex waves has been shown using a special technique and the proof [3] of the existence of an infinite set of complex roots of the dispersion equation (DE) describing waves in DR and GL.

In this work, a development of the analytical and numerical methods [2, 3] are considered for the analysis of the electromagnetic wave propagation in metal-dielectric waveguides with multi-layered dielectric filling. The first step constitutes extension of the results obtained for symmetric complex waves in DR and GL to the case of non-symmetric (angle-dependent) waves, and the second step, to multi-layered dielectric covers. Both steps are accomplished using specific forms of DEs obtained in [3] by construction analytical continuation of the functions involved in DEs to multi-sheet Riemann surfaces of the spectral parameter and applying appropriate generalization the techniques [4] for finding complex roots of the DEs.

Calculation of non-symmetric complex waves employs numerical solution of the DEs with the help of parameter differentiation in the complex domain using multi-parameter setting and analysis of implicit functions of several complex variables [5] and reduction [2, 3] to numerical solution of auxiliary Cauchy problems.

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