Exponentially convergent sparse discretization for layered media and application to near surface geophysical inversion

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I will introduce a new piecewise linear finite element semi-discretization of layered media that can obtain exponential convergence of the solution at select interfaces. The key features of the discretization are (a) use of midpoint integration to evaluate the contribution matrices, and (b) an unconventional mapping of the mesh into complex space. Named complex-length finite element method (CFEM), the technique is linked to Padé approximants that provide exponential convergence of the Dirichlet-to-Neumann maps and thus the solution at specified points in the domain. Exponential convergence facilitates drastic reduction in the number of elements. This, combined with sparse computation associated with linear finite elements, results in significant reduction in the computational cost. In this talk, I will explain the basic ideas of CFEM, and present our follow-on work on applying this to guided wave dispersion in layered media, and inversion of near-surface geophysical layers.