Discrete Symbol Calculus for computational wave propagation

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The computational and memory complexity of solving the time-dependent wave equation traditionally scales faster than linearly in the complexity of the initial or boundary data. Such behavior is currently hampering the resolution of large-scale inverse scattering problems such as reflection seismology. In this talk I will report on some algorithmic progress toward resolving this issue by means of discrete symbol calculus for compression and manipulation of the linear operators that appear in the context of wave propagation. In particular, I will present (i) a method for computing square roots of elliptic pseudodifferential operators near-exactly, (ii) a fast preconditioner for the Helmholtz equation in variable media, and (iii) a method for manipulating Green’s functions, all in complexity independent of the size of the dataset of wavefield measurements. Joint work with Lexing Ying from UT Austin.