Dirac Assisted Tree Method for Helmholtz Equations with Large Wavenumbers

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The Helmholtz equation models wave propagation in the time harmonic setting. It is encountered in many applications such as electromagnetics, geophysics, and ocean acoustics. Due to its highly oscillating solution, the Helmholtz equation is challenging to solve numerically. To obtain a reasonable solution, a grid size that is much smaller than the reciprocal of the wavenumber is usually required (also known as the pollution effect). In this talk, we introduce a new method called the Dirac Assisted Tree (DAT) method, which can handle 1D heterogeneous and special 2D Helmholtz equations with large wavenumbers. DAT breaks an original global problem into many parallel tree-structured small local problems, which are then assembled by small Dirac linking problems. To solve the local problems in DAT, we propose a compact finite difference method with arbitrarily high accuracy order. Furthermore, motivated by our stability results, we present a hybrid Fourier-DAT method which handles 2D Helmholtz equations with inhomogeneous mixed boundary conditions. This is joint work with Bin Han and Yau Shu Wong.