Calderon preconditioners for periodic FMMs in wave transmission problems

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Wave problems in periodic domains have many interesting applications such as photonic crystals and metamaterials in Maxwell's equations and phononic crystals in elastodynamics, etc. Fast multipole methods are effective as solvers of such problems, particularly when the problems are of scattering type. In view of this, we have developed periodic FMMs for various wave problems. We are now interested in preconditioners suitable for periodic FMMs. In this talk we shall discuss our recent efforts on the use of preconditioners based on Calderon's formulae in periodic transmission problems in Helmholtz equation and elastodynamics. In Helmholtz, we shall show that the matrix of the discretised integral equations itself serves as an effective preconditioner if the integral equation is discretised with collocation. This fact leads to a very simple preconditioning scheme with GMRES as the solver. We shall also see that a simple preconditioning is possible with Galerkin discretisation. These preconditioners are shown to be effective near anomalies related to the periodicity of the problem. Finally, we shall discuss similar preconditioners in elastodynamics and have some comments on Maxwell's equations.