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*Surface Partial Differential Equation Solvability and Eigenvalues with Symmetric Meshfree Methods*

We present a novel technique and analysis for investigating the solvability of certain linear partial differential equations (PDEs) using underdetermined Fourier extensions or symmetric Hermite radial basis function methods. The technique applies to surface PDEs as well as flat domain problems.

While much recent work has been completed on using meshfree methods for solving a wide range of PDEs, the spectra of operators discretized using radial basis functions (RBFs) suffers from the presence of non-physical eigenvalues (spurious modes). This makes many RBF methods unhelpful for eigenvalue problems. Our technique provides a rigorously justified process for finding eigenvalues based on a result concerning the norm of a Hermite RBF solution in its native space; specifically, only PDEs with solutions in the native space produce RBF solutions with bounded norms as the fill distance approaches zero.

The approach also works with underdetermined Fourier extensions: our own related approach with certain flexibility and stability advantages. Importantly, both the Fourier extension and Hermite RBF methods for eigenvalues can be used for surface eigenvalue problems. Meshfree methods are desirable for surface problems due to the increased difficulties associated with mesh creation and refinement on curved surfaces.