Galerkin and Collocation Meshfree Methods: From Continuum to Quantum

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ABSTRACT

Meshfree methods can be collectively classified as Galerkin type and collocation type. Galerkin type formulation in conjunction with approximation functions with polynomial reproductivity yields algebraic convergence. Through three classes of problems at continuum macro-scale, meso-scale, and quantum-scale, we demonstrate the convergence properties of Galerkin meshfree approach and how it can be constructed to alleviate the numerical difficulties associated with the standard finite element methods. The examples include large deformation and fragment impact problems, modeling of microstructure evolution, and solution of Schrodinger equation in quantum mechanics.

Alternatively, radial basis collocation method offers exponential convergence. However, the method is suffered from the large condition numbers due to its "nonlocal" approximation, and the nonlocality of radial basis function limits its application to small scale problems. In the second part of this talk, we show how to combine the advantages of radial basis function and reproducing kernel function to yield a local approximation that is better conditioned than that of the radial basis collocation method, while at the same time offers a higher rate of convergence than that of Galerkin type reproducing kernel method.