Multiscale Modeling in Mechanics and Materials

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ABSTRACT

In this presentation, multi-scale computational methods for continuum mechanics are first introduced. In particular, the "reproducing kernel" and the "wavelet" based multi-scale numerical methods as well as an energy based consistent asymptotic expansion formulation will be presented. Methods for bridging physics on different scales and the corresponding computational techniques for solving coupled problems will then be discussed. Model problems include coupling of coarse and fine scale responses in continua, bridging of continuum and meso scales, multi-scale wavelet projection method for continuum-meso and molecular structures, and adaptive partition of unity method in quantum calculation. Several examples will be given to demonstrate the proposed multi-scale methods. This include modeling of damage and fragment processes, grain structure evolution in polycrystalline materials, wrinkling formation in sheet metals, coupling of meso-scale dislocation and continuum mechanics, coarse graining of DNA molecules, and solution of Schrödinger equation in quantum physics.