Peridynamics as a Multiscale Material Model

Uncertainty Quantification in Atomistic-to-Continuum Methods
for Complex Molecular Systems

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Abstract

Peridynamics is a nonlocal reformulation of classical continuum mechanics. As a nonlocal model, peridynamics possesses a length scale represented by its interaction range, or horizon. This motivates the use of peridynamics as a multiscale material model, in the sense that the peridynamic equation may exhibit different behavior depending on the choice of length scale. Peridynamics can be connected to other classical models at different scales, such as molecular dynamics and classical elasticity. For finite horizons, peridynamics can be cast as a continualization of molecular dynamics, allowing peridynamics to reproduce nonlocal behavior inherent to nonlocal discrete models, at a lower computational cost. The microscale behavior is lost at the classical elasticity scale, represented by a peridynamic model with very small horizon; in this limit, the peridynamic model becomes local. For multiscale purposes, we are interested in bridging different length scales; this work provides insights related to the coupling of local and nonlocal models in peridynamics.