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ABSTRACT:

On the Consistency Conditions of Discrete-to-Continuum Transition

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We discuss the correspondence between discrete and continuum models, which plays an important role in mechanics. In fact, the relationship between discrete models, such as lattice dynamics, and continuum models has been extensively discussed in numerous studies, see e.g [1] and the references therein. Nevertheless, this connection remains a relevant topic in multiscale analysis in nanotechnology and other fields. In addition to nano- and micromechanics, significant progress has been made in engineering new composites, such as beam-lattice metamaterials. In some cases, these metamaterials require generalized continuum models, such as strain gradient elasticity or micropolar/micromorphic media (see, for example, [2]).

The aim of this lecture is to discuss the correspondence between discrete and continuum models. We propose some criteria such as positive definiteness/material stability/hyperbolicity as consistency conditions for continuum models. As a result, generalized continuum models may be necessary because simple (Cauchy-type) continuum models may be insufficient. The general theory is illustrated with three physical examples. Two of these examples require more general continuum models because their simple continuum counterparts do not satisfy the positive definiteness condition. The third example shows that the necessity of a generalized model depends on the stiffness parameters. We also discuss possible generalizations.

[1] V.A. Eremeyev, I. Berinskii. *Continuum Mechanics and Thermodynamics*, 38(1) (2026).

[2] V.A. Eremeyev, I. Berinskii. *Composite Structures*, 375, art. no. 119798 (2026).