Symposium | A. Advances in Materials Theory for Multiscale Modeling

[SY-A9]Symposium A-9

Chair: Eliot Fried(Okinawa Institute of Science and Technology, Japan)
Thu. Nov 1, 2018 9:45 AM - 11:00 AM Room6

[SY-A9]On the crucial role played by instantaneous and hidden multifield features of lattice dynamics in their nonlocal pseudocontinuum modeling

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In the past, a very large number of investigations has been interested in building various continuum descriptions of periodical mass-spring lattices which are capable of capturing at least some microscopically fast and microscopically localized phenomena that cannot be handled correctly by the classical continuum theories relying on a single displacement field. Very few of these works have however tried to illuminate some of the less well-known aspect of the concept of “action-at-a distance” involved in periodical mass-spring lattices, namely the “instantaneous propagation of disturbances”,
and its nonlocal effects in finite material systems. These instantaneous features, that are developed in the present work, have notably been discussed formerly partly by Lord Rayleigh and T.H. Havelock for other dispersive media and more recently evoked by M. Charlotte and L. Truskinovsky. Such features have although been ignored or minimized up to now in most derivations of pseudocontinuum hamiltonian models of elasticity. In order to account for these features, the alternative viewpoint developed here uses on an implicit but somewhat standard multi-displacement field description of the periodical mass-spring lattice motions and their (spatially nonlocal) pseudocontinuum wave mechanic representations which allow to deal in the same framework with both quasi-continuum (atomically diffuse) and anti-continuum (atomically localized) phenomena in finite material systems. In particular, the focus is put on the lattice motions of a simple finite particle chain with nearest neighbor interactions owing to its simplicity, complete analyticity, and physical clearness. The current analysis also explores an alternative standpoint, including both bulk- and boundary-dependent multi-field or multi-modal continuum descriptions, and that may constitute a new direction in which the continuum modeling theory could be fundamentally generalized. Thus, the outcome of the present multi-field approach is merely another non-classical quasi-continuum elastodynamics with both non-trivial nonlocal inertia and elasticity whose complexity depends naturally on the non-trivial interplay between the atomic bulk interactions and the boundary conditions.