Field Dislocation Mechanics: mechanical structure, driving forces, and computational approximation

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A recently developed [1,2,3] mechanical theory of field dislocation mechanics of unrestricted nonlinearity, both in material response and kinematics, is presented. The only constitutive ingredients of the theory are the specification of crystal elasticity, dislocation velocity, and dislocation nucleation rate. The theory is nonlocal – consequently, the identification of thermodynamic driving forces for the dissipative mechanisms is nonstandard, as is the derivation for the constitutive equation for plastic distortion as well as the form of the stress in terms of the free energy. The results establish an exact analog of the Peach-Koehler driving force for dislocation velocity, thus lending credibility to the theoretical structure, as well as providing a prediction for a driving force for dislocation nucleation.

Some approximate (computational) results of the theory will be presented to show its capability with regard to the representation of equilibrium and nonequilibrium behavior of solids containing dislocations. This is joint work with Anish Roy.

[1] Acharya, A. (2001) A model of crystal plasticity based on the theory of continuously distributed dislocations, *Journal of the Mechanics and Physics of Solids*, 49, 761-784.

[2] Acharya, A. (2003) Driving forces and boundary conditions in continuum dislocation mechanics, *Proceedings of the Royal Society, London, A*, 459, 1343-1363.

[3] Acharya, A. (2003) Constitutive analysis of finite deformation field dislocation mechanics, in press *Journal of the Mechanics and Physics of Solids.*