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Scaling theory of continuum dislocation dynamics in two and three dimensions YONG S. CHEN, WOOSONG CHOI, STEFANOS PAPANIKOLAOU, JAMES P. SETHNA, Cornell University — When crystalline materials deform plastically, complex dislocation structures have been observed experimentally.[1] We provide a continuum plasticity theory to study the emergent self-similar morphologies.[2] We analyze the self-similarity in terms of critical exponents for correlation functions of dislocation density, crystalline orientation and plastic distortion, and explore the connection to the power spectrum of the total free energy. In two and three dimensions, we apply anisotropic loadings, and observe little anisotropy in the critical properties. We explore the addition of quenched disorders to our continuum theory, to investigate the relation between dynamics (plasticity avalanches) and static dislocation morphologies.

[1]P. Hahner et al., Phys. Rev. Lett. 81, 2470, 1998.
[2]Y.S.Chen et al., Phys. Rev. Lett. 105, 105501, 2010.

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