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Continuum dislocation dynamics: analogies to fluid turbulence? WOOSONG CHOI, YONG CHEN, STEFANOS PAPANIKOLAOU, JAMES SETHNA, LASSP, Cornell University — The dislocations which mediate plastic flow in crystals are described in the continuum with a nine-component tensor field. We study a nonlinear evolution law for this dislocation density, which shows several intriguing analogies to fully developed turbulence. (a) As in the infinite Reynolds number limit, where vortex singularities are conjecured to form in finite time, our equation form wall singularites related to those in Burger's equation[1]. To resolve these walls accurately we apply a central upwind scheme[2]. (b) As in turbulence, we find self-similarity and scaling in the resulting cell wall morphologies when dislocation climb is forbidden. When climb is allowed (i.e., high temperatures) we form non-fractal walls representing grain boundaries. (c) As in turbulence, where chaos allows only statistical convergence at long times, our two-dimensional simulations appear to have no weak solutions in the continuum limit – the cascade of structure to short length scales appears to be sensitively dependent on the ultraviolet cutoff.

[1]S. Limkumnerd and J. P. Sethna, Phys. Rev. Letters **96**, 095503 (2006)
[2]A. Kurganov and E. Tadmor, J. of Comp. Phys. **160**, 1, 241-282 (2000)

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