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Scale-free avalanche dynamics in crystal plasticity[1] PATER DUSAN ISPANOVITY, Eotvos University Budapest, Hungary, LASSE LAURSON, Aalto University, Espoo, Finland, MICHAEL ZAISER, University of Erlangen-Nuernberg, Germany, STEFANO ZAPPERI, CNR-IENI, Milano, Italy; ISI Foundation, Torino, Italy, ISTVAN GROMA, Eotvos University Budapest, Hungary, MIKKO ALAVA, Aalto University, Espoo, Finland — We investigate the properties of strain bursts (dislocation avalanches) occurring during plastic deformation of crystalline matter using two dimensional discrete dislocation dynamics (DDD). We perform quasistatic stress-controlled simulations with three DDD models differing in the spatiotemporal discretization and the mobility law assumed for individual dislocations. We find that each model exhibits identical avalanche dynamics with the following properties: (i) strain burst sizes follow a power law distribution characterized by an exponent $\tau \approx 1.0$ and (ii) the distribution in truncated at a cutoff that diverges with increasing system size at any applied stress level. It has been proposed earlier that plastic yielding can be described in terms of a continuous phase transition of depinning type and its critical point is at the yield stress. We will demonstrate, however, that our results are inconsistent with cutoff scaling in depinning systems (like magnetic domain walls or earthquakes) and that the system behaves as critical at every stress level. We, therefore, conclude that in the models studied plastic yielding cannot be associated with a continuous phase transition.

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