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Brittle Fracture In Disordered Media: A Unified Theory[1]
ASHIVNI SHEKHAWAT, Cornell University, STEFANO ZAPPERI, Consiglio Nazionale delle Ricerche-IENI, Via R. Cozzi 53, 20125 Milano, Italy, JAMES SETHNA, Cornell University — We present a unified theory of fracture in disordered brittle media that reconciles apparently conflicting results reported in the literature, as well as several experiments on materials ranging from granite to bones. Our renormalization group based approach yields a phase diagram in which the percolation fixed point, expected for infinite disorder, is unstable for finite disorder and flows to a zero-disorder nucleation-type fixed point, thus showing that fracture has mixed first order and continuous character. In a region of intermediate disorder and finite system sizes, we predict a crossover with mean-field avalanche scaling. We discuss intriguing connections to other phenomena where critical scaling is only observed in finite size systems and disappears in the thermodynamic limit. We present a numerical validation of our theoretical results.

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Ashivni Shekhawat
Cornell University

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