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Size distributions of shocks and static avalanches from the functional renormalizable group. (English summary)

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Elastic interfaces can be modelled by a one-component displacement field $u(x) = u_x$ subject to a random potential $V(u,x)$ and to a harmonic well centered at $u_x = w_x$. The potential V is assumed to have a second cumulant $\delta(x-x')R_0(u-u')$, where the form of the function R_0 determines the universality class: R_0 can be short range (random bond disorder), periodic (random periodic disorder), or long range of the form $R_0(u) \sim -\sigma|u|$ (random field disorder). The case of uniform $w_x = w$ is explicitly considered: the minimum energy configuration $u_x(w)$ is known to consist of a smooth part and jumps, called shocks or static avalanches.

The size distribution $P(S)$ of shocks is studied through the functional renormalization group: first, a tree-level calculation is considered (i.e. loops are neglected), and this leads to a mean field result. Next, a resummation of all one-loop contributions is performed, and a distribution

$$P(S) \sim S^{-\tau} \exp(C(S/S_m)^{1/2} - B(S/S_m)^{\delta})$$

is obtained, where S_m is a large-scale cutoff, and B, C, δ, τ are parameters, which are computed to first order in $\epsilon = 4-d$, with d being the internal dimension of the interface. The result for the exponent τ is found to be consistent (to order ϵ) with the relation $\tau = 2-2/(d+\zeta)$ (with ζ the so-called static roughness exponent), which is conjectured to hold at depinning. The calculations apply to all the aforementioned static universality classes.

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