Force correlations in disordered systems and this year's Nobel prize in physics

Prof. Dr. Kay Wiese

Laboratoire de Physique Théorique, Ecole Normale Supérieure, Paris

We study the force-force correlator for disordered elastic systems. We show that each of the relevant universality classes has its own function. The nicest experiments are for DNA unzipping and Barkhausen noise. For the latter we observe two distinct universality classes, depending on the range of spin interactions. In all cases force-force correlations grow linearly at small distances, while they are bounded at large distances. As a consequence, avalanches are anti-correlated, i.e. reduced in size, at short distances.

Our theory is based on the functional renormalization group, which we compare to an alternative approach, namely mean-field theory with replica-symmetry breaking. The latter is one of the key achievements cited in this year's Nobel prize for Giorgio Parisi. Another involves super mathematics, which we use to map charge-density waves to loop-erased random walks.