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Current Flow in Random Resistor Networks: The Role of Percolation in Weak and Strong Disorder ZHENHUA WU, EDUARDO LÓPEZ, Center for Polymer Studies, Boston University, SERGEY BULDYREV, Yeshiva University, LIDIA BRAUNSTEIN, Universidad Nacional de Mar del Plata, Argentina, SHLOMO HAVLIN, Bar-Ilan University, Ramat Gan, Israel, EUGENE STANLEY, Center for Polymer Studies, Boston University — We study the current flow paths between two edges in a random resistor network on a $L \times L$ square lattice. Each resistor has resistance e^{ax}, where x is a uniformly-distributed random variable and a controls the broadness of the distribution. We find (a) the scaled variable $u \equiv L/a^{\nu}$, where ν is the percolation connectedness exponent, fully determines the distribution of the current path length ℓ for all values of u. For $u \gg 1$, the behavior corresponds to the weak disorder limit and ℓ scales as $\ell \sim L$, while for $u \ll 1$, the behavior corresponds to the strong disorder limit with $\ell \sim L^{d_{\rm opt}}$, where $d_{\rm opt} = 1.22 \pm 0.01$ is the optimal path exponent. (b) In the weak disorder regime, there is a length scale $\xi \sim a^{\nu}$, below which strong disorder and critical percolation characterize the current path.

Zhenhua Wu
Center for Polymer Studies, Boston University

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