Critical Scaling at the Anderson Localization Transition in the Strong Multifractality Regime

Oleg YEVTUSHENKO
Ludwig Maximilians Universitaet
LS von Delft
Theresienstr, 37
D-80333 Muenchen
GERMANY

We study dynamical scaling (DS) in disordered systems at (or close to) the point of the Anderson localization transition. Wave functions of such systems are fractal. DS is connected to strong spatial correlations of the wave functions. These correlations are particularly nontrivial in the strong fractality regime where fractals are very sparse. It has been conjectured [1] that there exists an exact relation between the exponent of DS and the 2nd fractal dimension. To the best of our knowledge, neither existence of DS nor the relation between the exponents were checked analytically.

We study DS and the critical exponents in the strong fractality regime using the model of almost diagonal random matrices with fractal eigenstates [2] by analyzing asymptotic behavior of the return probability in the long time limit. Since the nonlinear \sigma-model cannot be solved in the strong fractality regime we use an alternative field theoretical method: the SuSy virial expansion in a number of interacting energy levels [3].

We have proven the DS to hold true up to the leading terms of 2nd loop of RG. We discuss necessary conditions for the exact relation between the critical exponents.

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