

Hierarchy of relevant couplings in perturbative renormalization group transformations

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The phase diagram for the interacting fermions in weak coupling is described by the perturbative renormalization group equations. Due to the lack of analytic solutions for these coupled non-linear differential equations, it is rather subtle to tell which couplings are relevant or irrelevant. We propose a powerful classification scheme to build up the hierarchy of the relevant couplings by a scaling Ansatz found numerically. To demonstrate its superiority over the conventional classification for the relevant couplings, we apply this scheme to a controversial phase transition in the two-leg ladder and show that it should be a non-trivial crossover instead. The scaling Ansatz we propose here can classify the relevant couplings in hierarchical order without any ambiguity and can improve significantly how we interpret the numerical outcomes in general renormalization group methods.