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Perturbative non-Fermi liquids from dimensional regularization

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A dimensional regularization scheme for quantum field theories with Fermi surface is proposed to study scaling behaviour of non-Fermi liquid states in a controlled approximation.

Starting from a Fermi surface in two space dimensions, the co-dimension of Fermi surface is extended to a general value while the dimension of Fermi surface is fixed.

When Fermi surface is coupled with a critical boson centred at zero momentum, the interaction becomes marginal at a critical space dimension $d_c = 5/2$. A deviation from the critical dimension is used as a small parameter for a systematic expansion.

This method is applied to the theory where two patches of Fermi surface are coupled with a critical boson, and it is shown that the Ising-nematic critical point is described by a stable non-Fermi liquid state slightly below the critical dimension.

Critical exponents are computed up to the two-loop order.

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