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Generalized Hertz action for quantum criticality in Fermi systems

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We reassess the structure of the effective action and quantum critical singularities of two-dimensional Fermi systems characterized by the ordering wavevector $\vec{Q}=\vec{0}$. By employing infrared cutoffs on all the massless degrees of freedom, we derive a generalized form of the Hertz action, which does not suffer from problems of singular effective interactions. We demonstrate that the Wilsonian momentum-shell renormalization group (RG) theory capturing the infrared scaling should be formulated keeping $\vec{Q}$ as a flowing, scale-dependent quantity. At the quantum critical point, scaling controlled by the dynamical exponent z=3 is overshadowed by a broad scaling regime characterized by a lower value of z≈2. This in particular offers an explanation of the results of quantum Monte Carlo simulations pertinent to the electronic nematic quantum critical point.

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