Multiscale quantum criticality in nematic Fermi liquids

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Close to a nematic, i.e., Pomeranchuk instability, the Fermi surface in an isotropic metal becomes soft with respect to quadrupolar fluctuations. In spatial dimensions d=2, there are two critical bosonic modes that are characterized by different dynamics: one being ballistic with dynamical exponent z=2 and the other is Landau damped with z=3, giving rise to multiple dynamical scales. First, I discuss the analysis of the effective critical bosonic theory [1]. At temperature T=0, the z=2 mode governs the low-energy properties as it possesses the smaller effective dimension d+z. Its self-interaction leads to logarithmic singularities that can be summed with the help of the renormalization group. At finite T, the coexistence of two different dynamical scales leads to a modified quantum-to-classical crossover. It extends over a parametrically large regime with intricate interactions of quantum and classical bosonic fluctuations resulting in a universal temperature dependence of the correlation length. The multiple scales are also reflected in thermodynamics and the phase diagram. Second, the influence of the multiple energy scales on the electronic spectral function will be discussed [2]. Whereas the interaction with z=3 bosons gives rise to a singular local electron self-energy with a frequency dependence of non-Fermi liquid form, the exchange of z=2 bosons leads to an anomalous dimension for the electrons.

[1] M. Zacharias, P. Wölfle, and M. Garst, Phys. Rev. B **80**, 165116 (2009)
[2] Markus Garst and Andrey V. Chubukov, Phys. Rev. B **81**, 235105 (2010)