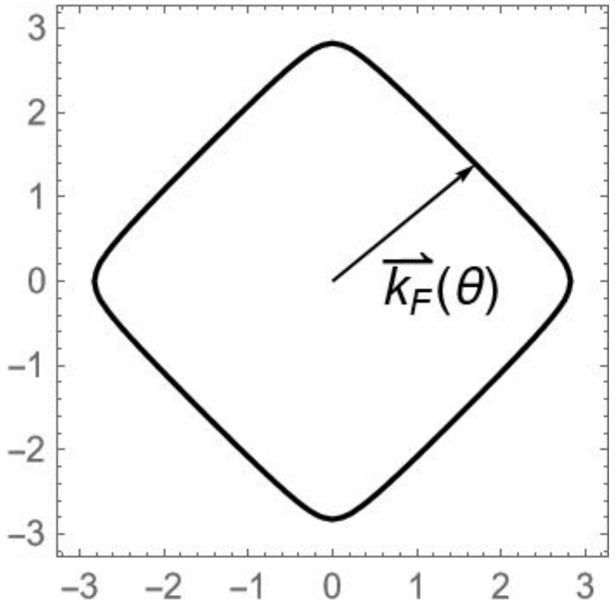
Critical Fermi surfaces of 2D fermionic systems

Theoretical Physics Symposium

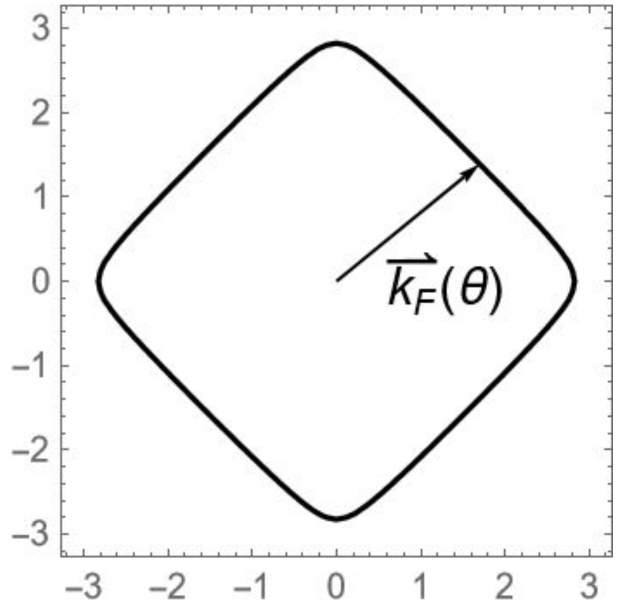
Mateusz Homenda

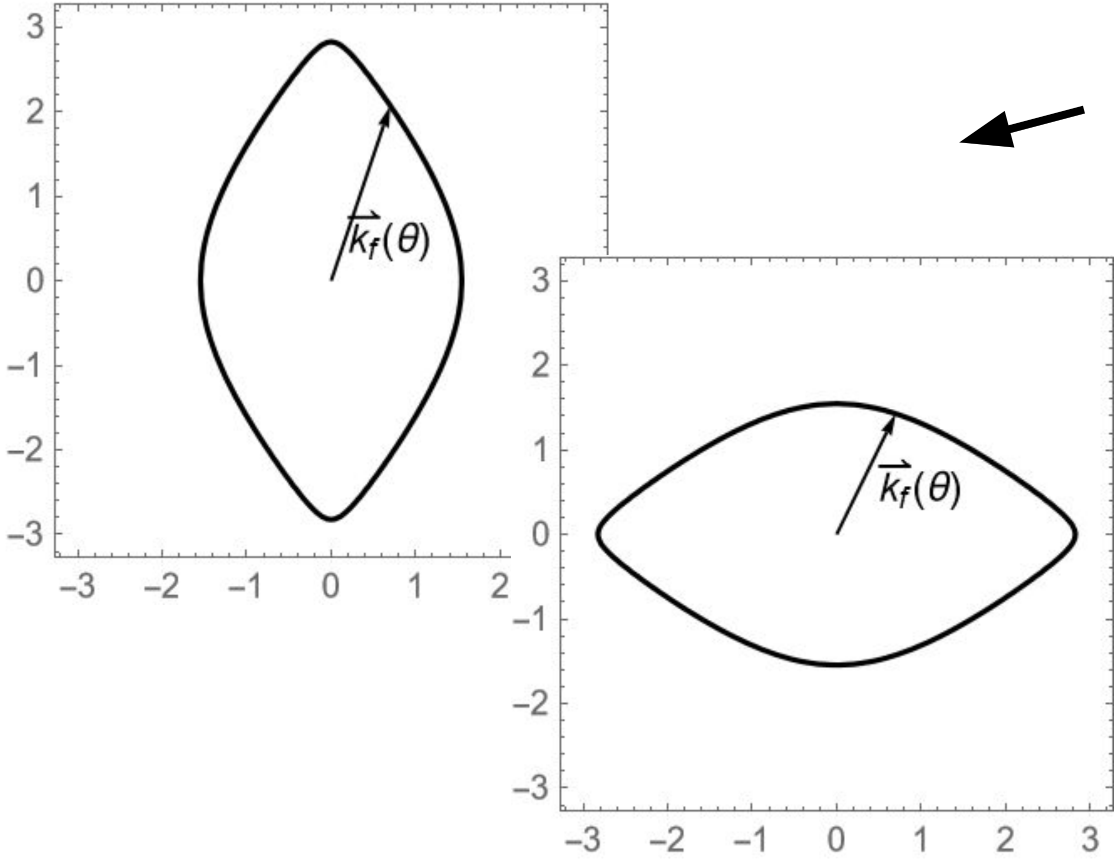
Fermi surface



Z_4 symmetry

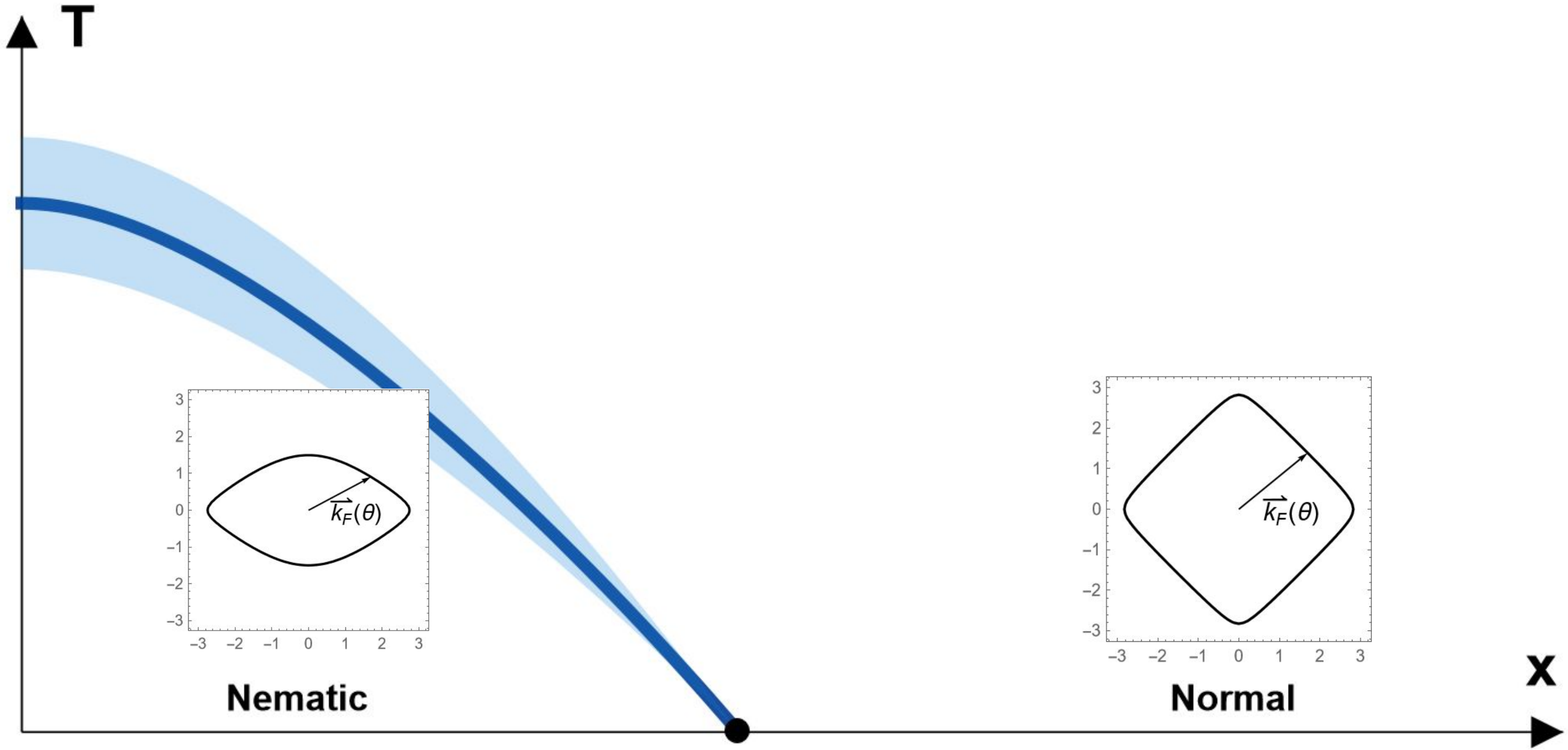
Fermi surface





Spontaneous symmetry breaking

Critical Fermi surface - nematic phase transition



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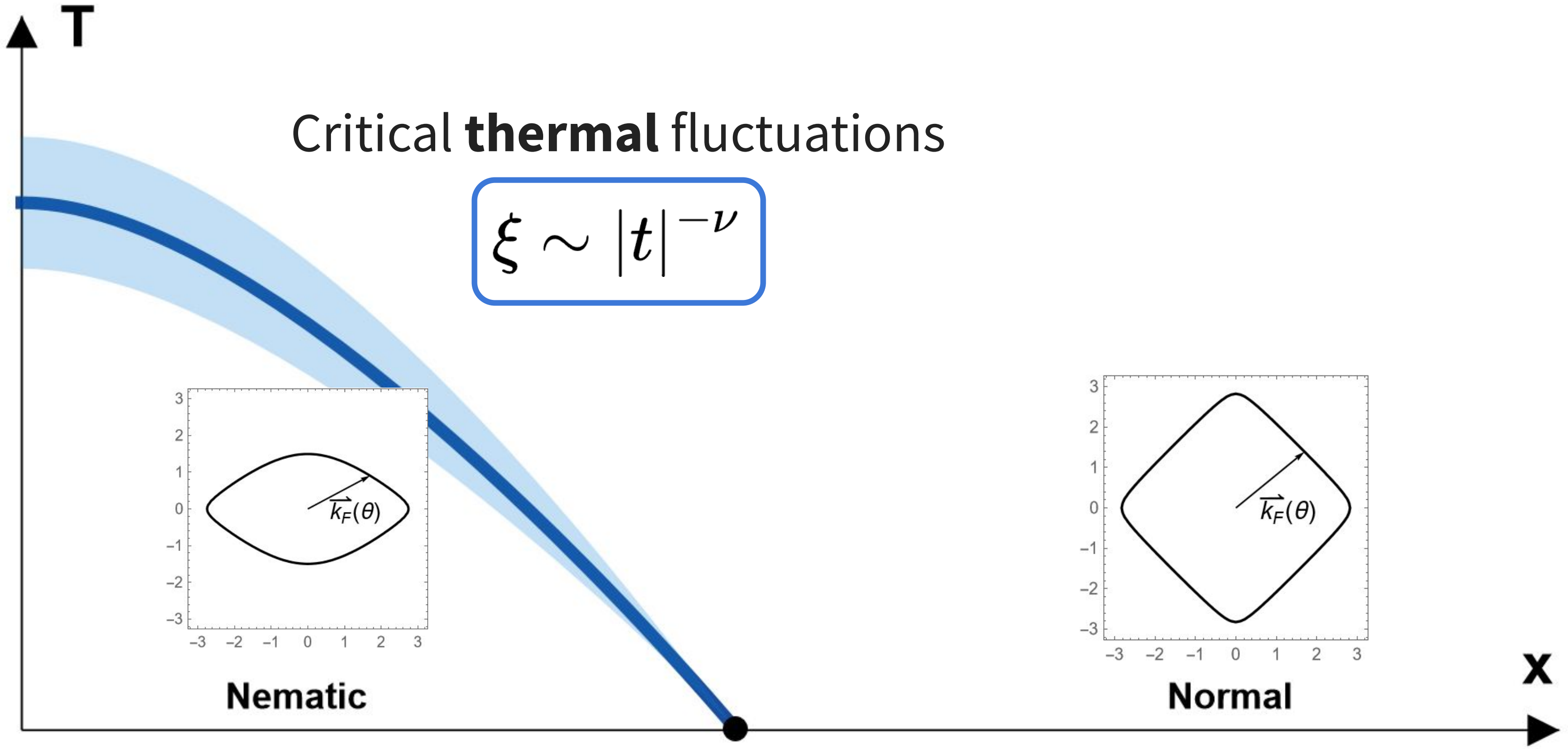

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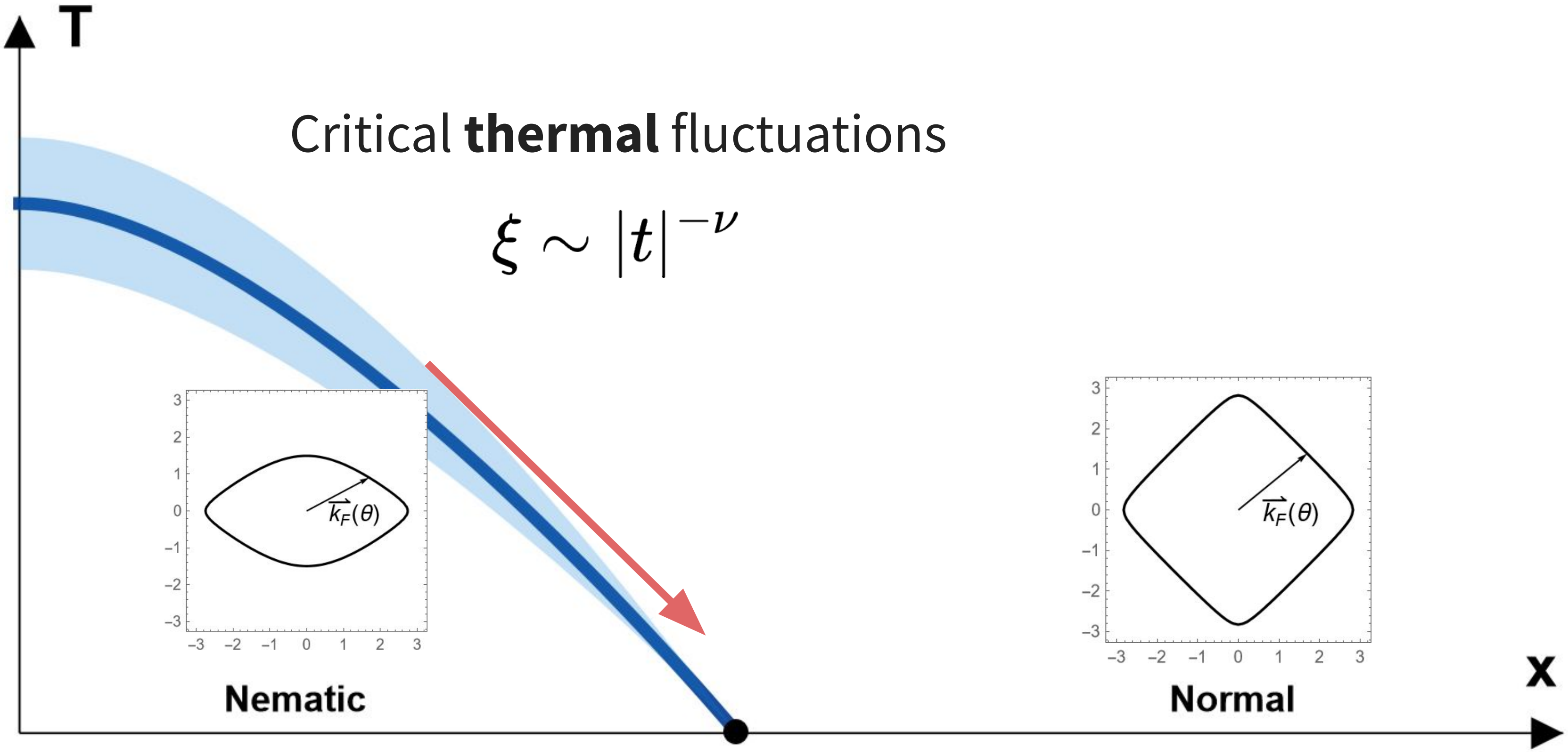
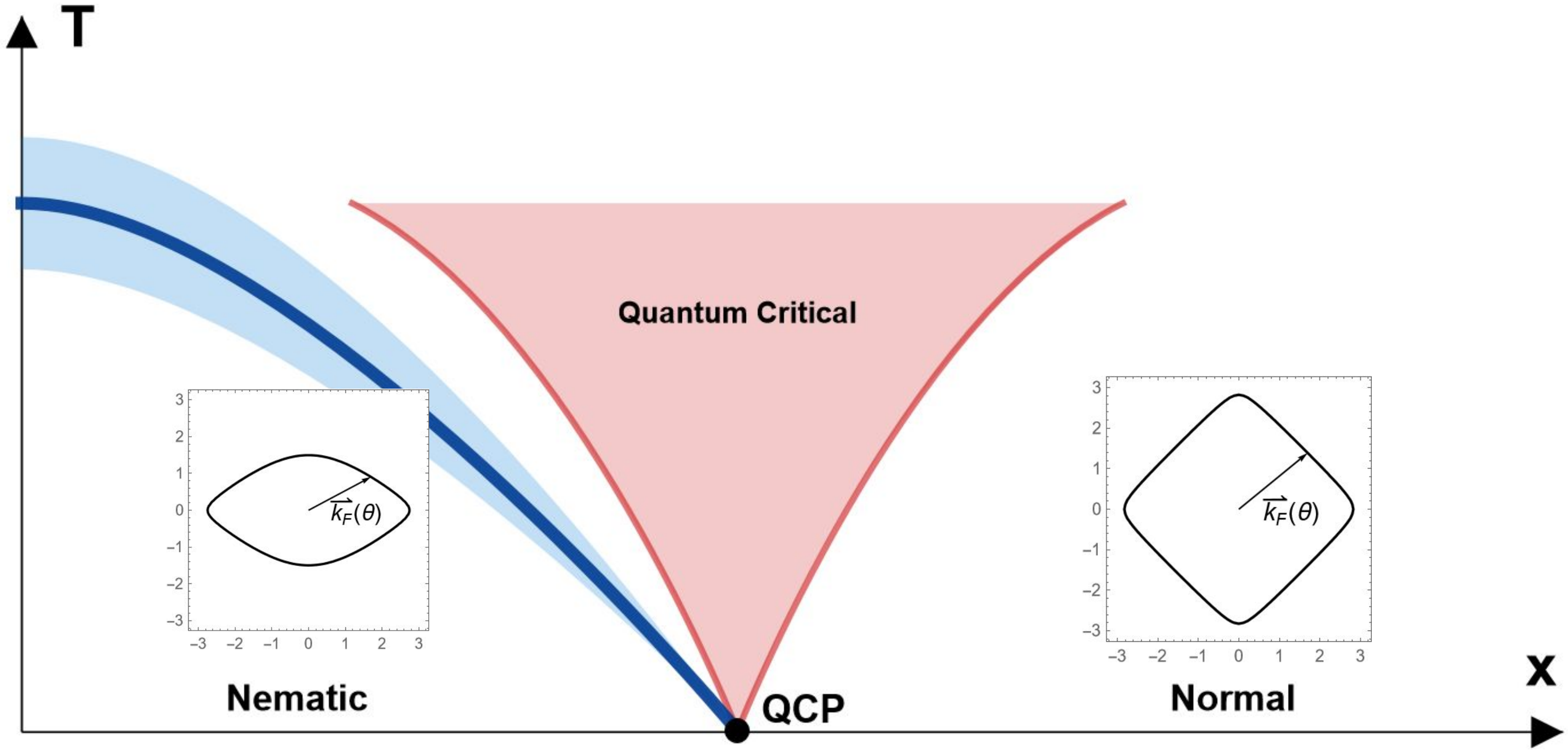
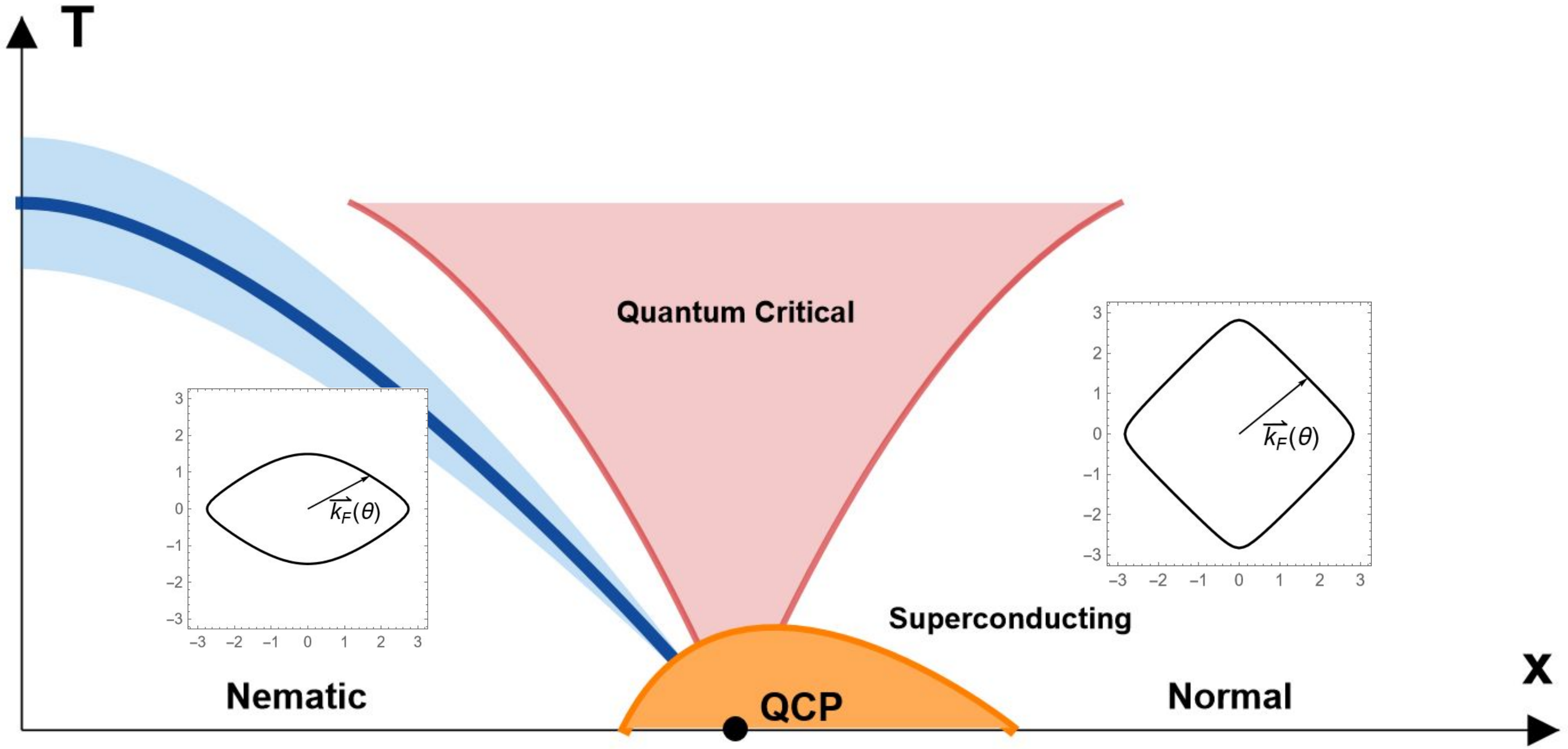


Critical Fermi surface - quantum fluctuations



What is the role of quantum fluctuations?



2D Fermi surface
+
gapless real field

The same universality class (**|q| = 0**):

- electronic-nematic
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- high dimensional bosonization
- Fermi liquid theory - Pomeranchuk instability for l = 2
- Hertz - Millis theory
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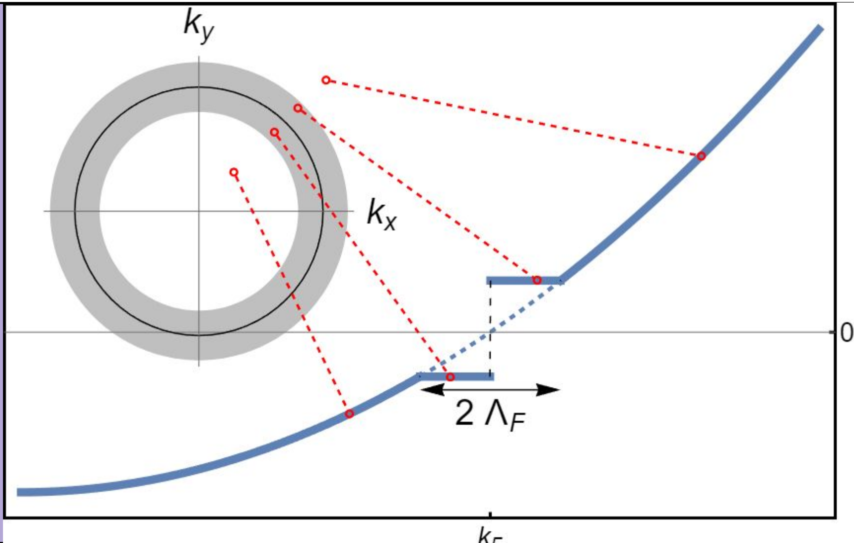

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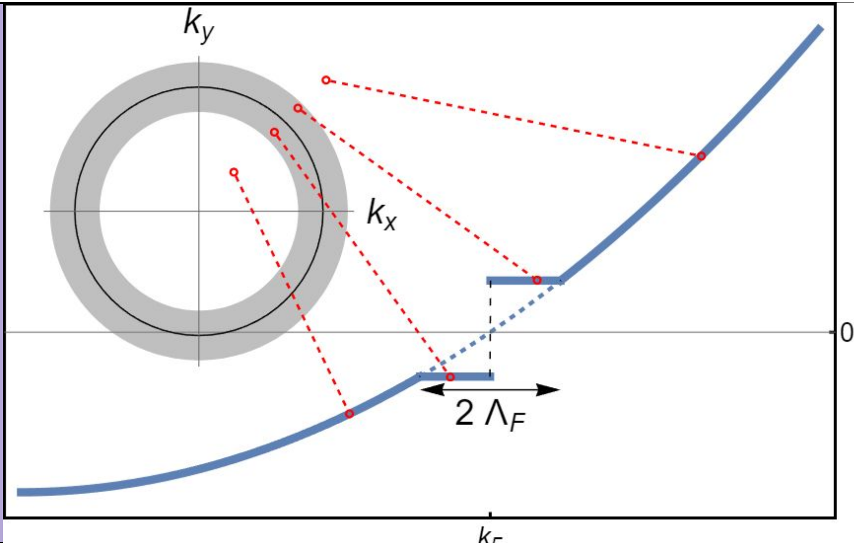

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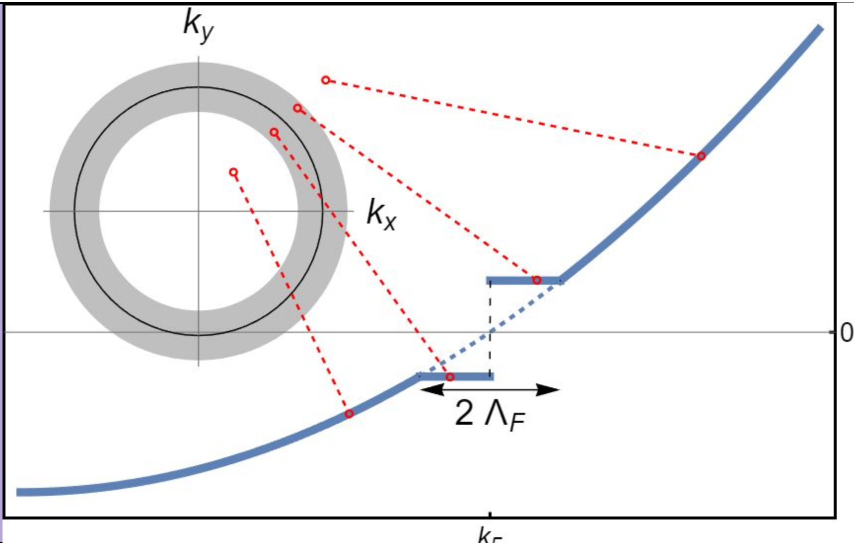
- spherical Fermi surface - neglect microscopic details (universality)
- two different regulators with momenta scales $\mathbf{\Lambda_F}$ and $\mathbf{\Lambda}$



Functional renormalization group - effective action

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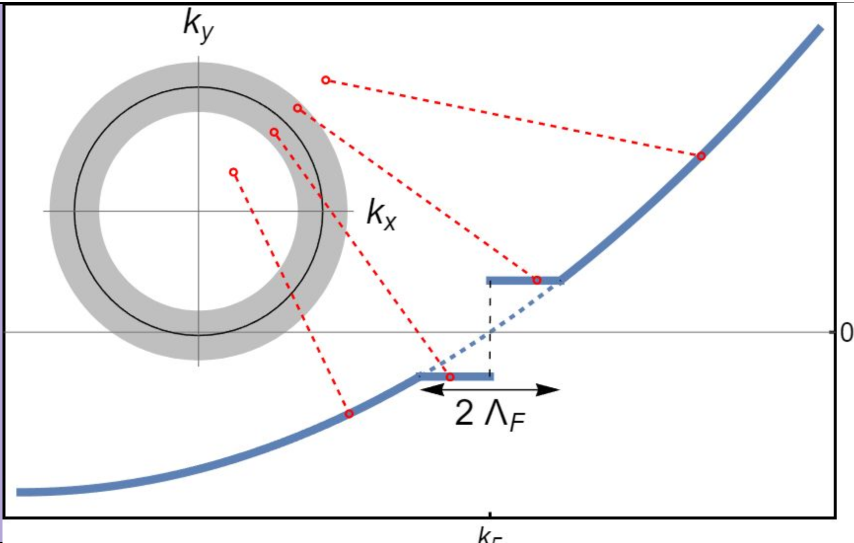

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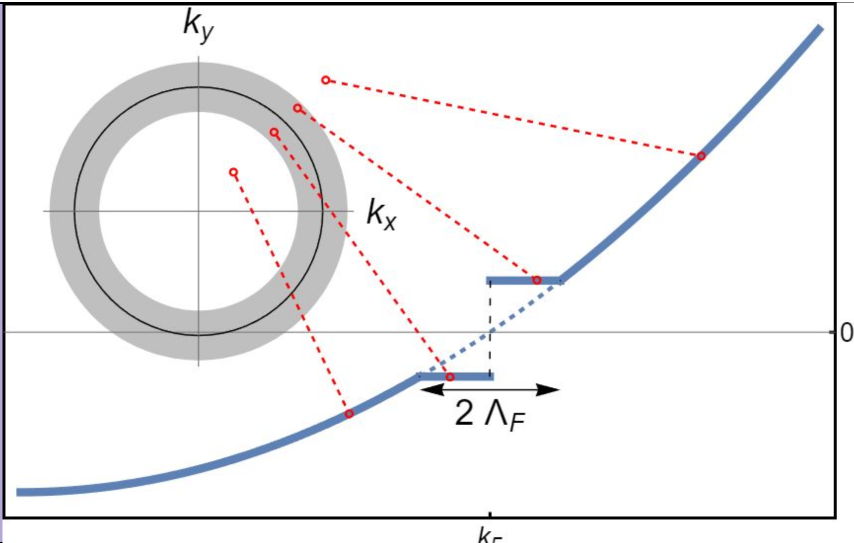
Wetterich flow equation

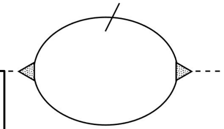
$$\partial_\Lambda \Gamma_\Lambda = \frac{1}{2}\mathrm{Tr}\Big[(\partial_\Lambda \mathbf{R}_\Lambda)(\Gamma^{(2)}_\Lambda + \mathbf{R}_\Lambda)^{-1}\Big]$$

$$\Gamma_\Lambda = \ln(Z[J_\phi, J_\psi]) - \int_x J_\psi \psi - \int_x J_\phi \phi$$



Results

- We found the way how to incorporate fermionic contribution in bosonic sector **(generalized Hertz action scheme)**.
- We calculated the relation between correlation time and correlation length **(dynamical exponent)**.
- We confirmed the non-fermi liquid behaviour of electrons but with different scaling.



Dynamical exponent

$$q_0 \sim |\mathbf{q}|^{z_b}$$

$$\Sigma_F \sim |k_0|^{0.5}$$