A Functional Integral Approach to Magnetism and Superconductivity

Sondre Duna Lundemo
Supervisor: Asle Sudbø

December 1, 2022

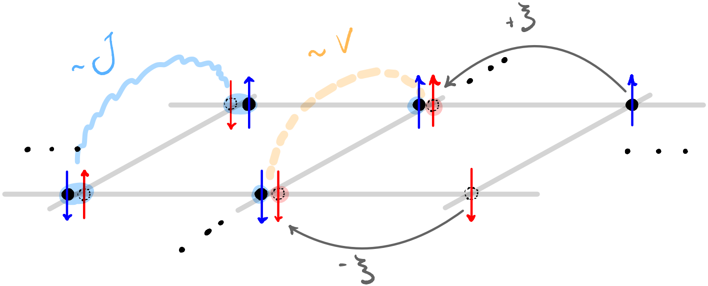
Ginzburg-Landau Theory for itinerant ferromagnetism and superconductivity

Model:

$$\mathcal{S}[\bar{\psi}, \psi] = \int_x \sum_\sigma \bar{\psi}_\sigma(x) \left[\partial_\tau + \xi(-\mathrm{i}\boldsymbol{\nabla})\right] \psi_\sigma(x) \qquad \text{(Free electrons)}$$

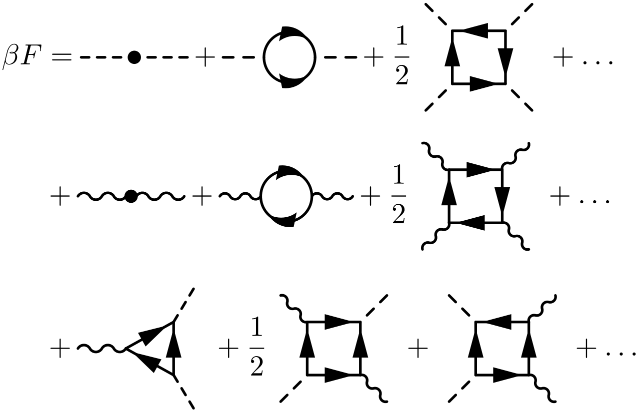
$$- \int_{x,y} \bar{\psi}_\uparrow(x)\bar{\psi}_\downarrow(y) V(x-y) \psi_\downarrow(y)\psi_\uparrow(x) \qquad \text{(Spin singlet SC)}$$

$$- \int_{x,y} J(x-y) \mathbf{S}(x) \cdot \mathbf{S}(y). \qquad \text{(Ferromagnetic exchange)}$$



Ginzburg-Landau Theory for itinerant ferromagnetism and superconductivity

Free energy functional

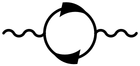


(Superconductivity)

(Magnetism)

(Coexistence)

Assorted results

Studying the particle-hole bubble  yields the critical temperature

$$T_{\text{curie}} = \frac{\omega_c}{2}\left(\operatorname{artanh}\left(\frac{2}{J\nu(0)}\right)\right)^{-1},$$

and the phase-diagram: