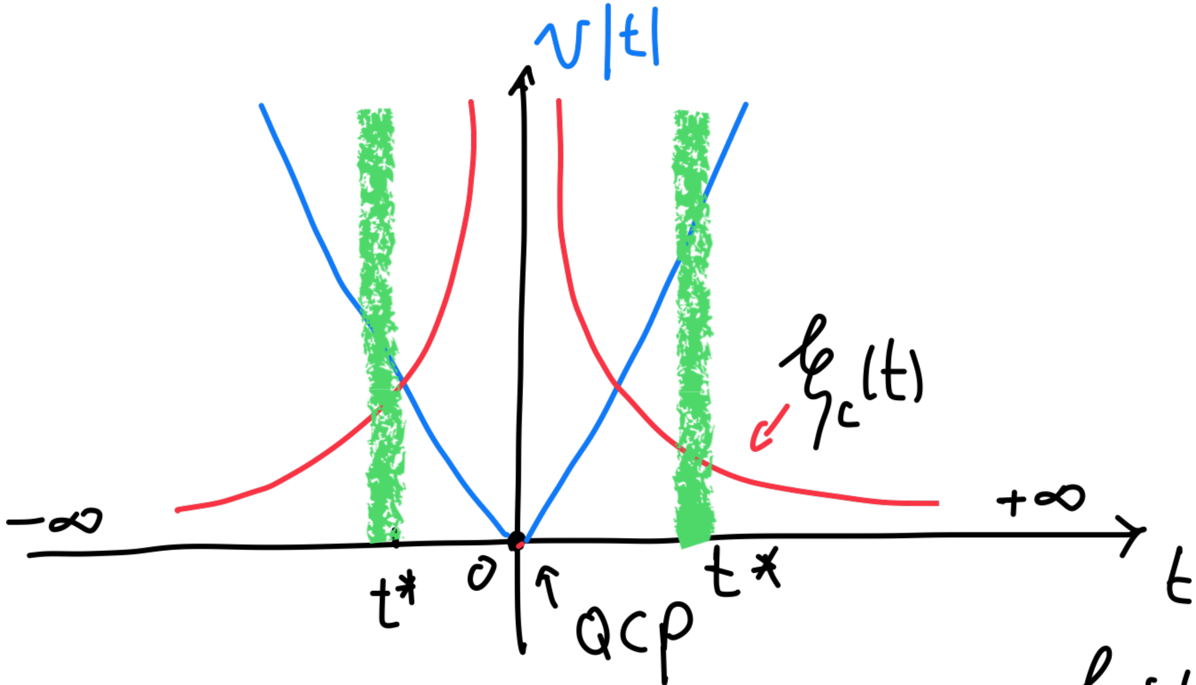
Phys525:
Quantum Condensed Matter Physics: Quantum Criticality
Basics, Dynamics and Topological criticality

Episode 14:
Application: Sweeping across a QCP:
introduction to quantum dynamics of Kibble-Zurek type

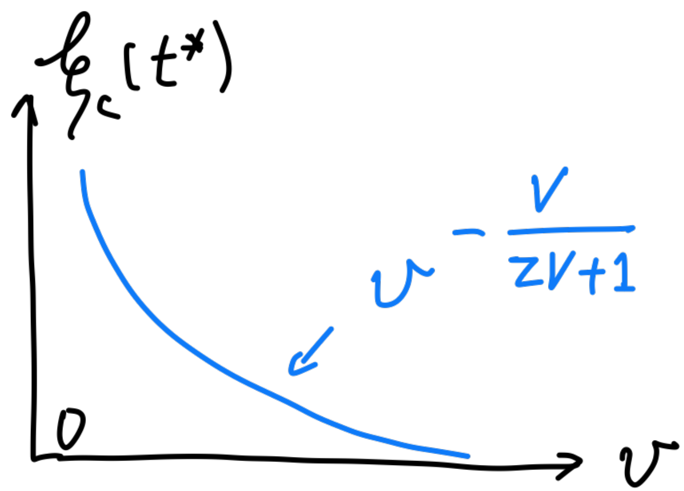


$$\xi_c \sim |J - J_c|^{-\nu}$$

$$\tau_c \sim \xi_c^{\,z}$$

$$\xi_c \sim (vt)^{-\nu}$$

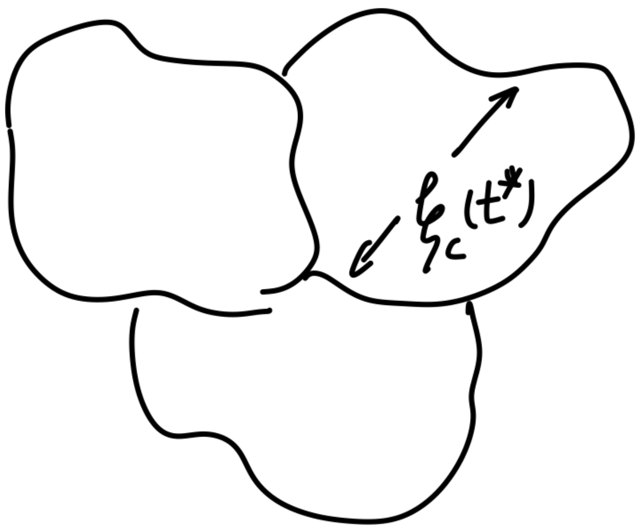
$$\xi_c(t^*) \sim v^{-\frac{\nu}{z\nu+1}}$$

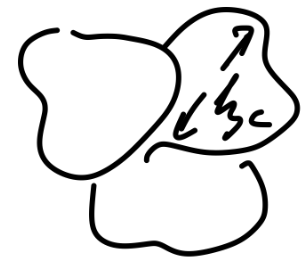


Only the excitations of size larger than $\xi_c(t^*)$ will be excited.

Cartoons (final state) of Quenched defects

slow Vs fast

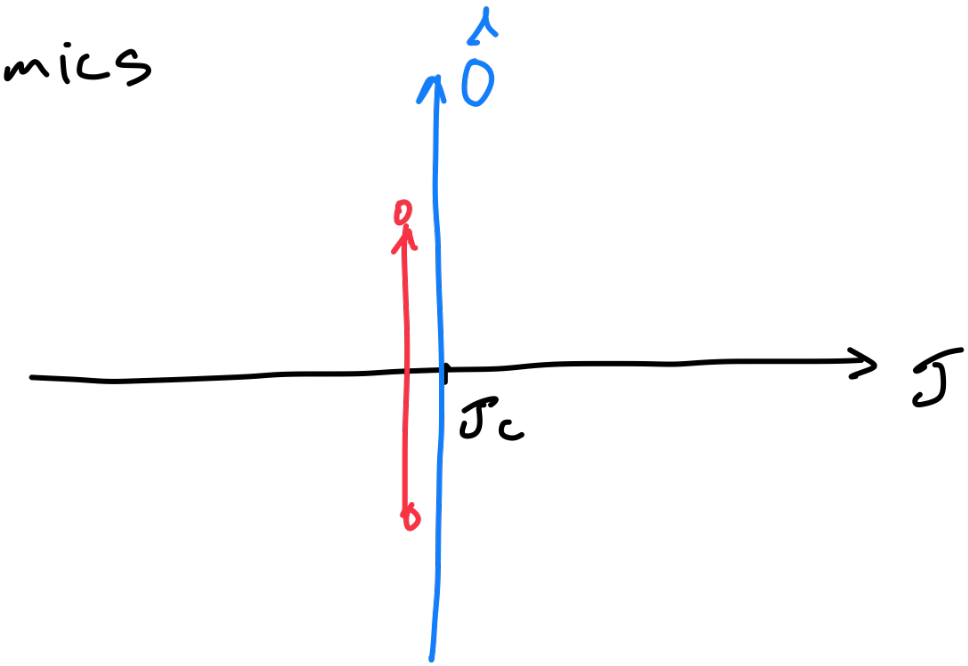




$$n(v) \sim \xi_c(t^*)^{-d} = v^{\frac{\nu d}{z\nu+1}}$$

density of defect excitations

General dynamics



P_L, the probability of finding excitations with "L" size?

$$P_L \approx \left| v \tau_L^2 \langle L | \hat{O} | 0 \rangle \right|^2 , \qquad \hat{O} = \int \hat{L}(x)\, d x^{(d)}$$

Only depends on the scaling dimension of $\hat{L}(x)$

General: beyond heuristics $\quad (P_n = |a_n|^2)$

$$P_L \approx \left| v \tau_L^2 \langle L | \hat{O} | 0 \rangle \right|^2, \qquad \hat{O} = \int \hat{L}(x)\, d x^{(d)}$$

if $x \to e^{\lambda} x'$, $\quad \hat{L}(x) \to \hat{L}'(x') = e^{\eta \lambda} \hat{L}(e^{\lambda} x')$

η the scaling dimension of $\hat{L}(x)$

then

$$P_L \approx \left(v L^{2z+d-\eta} \right)^2 + \cdots$$

Most likely excitations $L > L_c = v^{-\frac{1}{2z+d-\eta}}$.

(for $\hat{L}(x) = \varphi^{+}(x) \varphi(x)$, one can show that $z + d - \eta = \frac{1}{\nu}$.)

$\xi_c \sim |J - J_c|^{-\nu}$

then

$$P_L \approx \left(v\, L^{2z+d-\eta}\right)^2 + \cdots$$

(for $\hat{L}(x) = \varphi^{\dagger}(x)\varphi(x)$, one can show that $z+d-\eta = \frac{1}{\nu}$.)

$$\hat{O} = \int d^d x\, \hat{L}(x) , \qquad \hat{L}(x) \to \hat{L}'(x') = e^{\eta\lambda}\,\hat{L}(e^{\lambda}x')$$

$$\hat{O} \to \hat{O}' = e^{\lambda(d-\eta)}\,\hat{O}$$

$$\langle e^{\lambda}L \,|\, \hat{O} \,|0\rangle = \langle L|\,\hat{O}\,|0\rangle\, e^{\lambda(d-\eta)}$$

$$\longrightarrow \langle L|\,\hat{O}\,|0\rangle \sim L^{(d-\eta)}$$