Nernst Effect & Vortex Liquid in Cuprates [Ong]

Recall \( \tau_{BCS} = \Pi_k (u_k + e^{i\phi} v_k e^{-i\phi} C^{\dagger} e^{i\phi} C^\dagger) 10) \)

Andersen pseudo-spin representation: \( u_k(0) + v_k e^{i\phi}(0) \)

Compare to low-\( T_c \), noticed in high-\( T_c \) is "cheap & fast."

Also recall that Andersen-Higgs gives rise to phase stiffness:

Thus in superconductor, phase is uniform, \( J_p = \frac{1}{2} \int d^3 r \rho_s(\psi)^2 \)

But phase coherence destroy by mobile vortex (c.f. stiffness in gold. Dirty gold is harder to twist, since dislocation pinned

Hence this gives voltage jump

Expect:
It is believed (Emery & Kivelson) that loss of phase rigidity is the important limiting factor on $T_c$.

For Nernst coefficient, is heuristically given by:

\[ E_n = \frac{\nabla \Phi}{\nabla T} = \frac{B \Phi}{\eta} \left[ \eta \frac{\nabla T}{\nabla T} = \mathbf{F} = -s \mathbf{V} \right] \]

force exerted on vortex line by $\mathbf{V}$

\[ \eta \frac{\nabla T}{\nabla T} \] viscosity

\[ s \mathbf{V} \] line entropy

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\[ H_m \]

\[ H^m \]

\[ H_c \]

\[ \nabla \Phi \]

\[ \mathbf{F} \]

\[ s \]

\[ \mathbf{V} \]

\[ 30K < T_c \]

\[ 120K \times T_{max} \]

\[ \eta \]

\[ \text{normal q.p. contribution} \]

\[ \text{magneticization} \]

\[ \text{Meissner effect} \]

\[ \text{signal} \]

\[ \text{shape} \]

\[ \nabla \Phi \]

\[ \mathbf{F} \]

\[ \text{spontaneous vortex-antivortex generation} \]

\[ \text{But Cuprate is (though very anisotropic) 3D...} \]

* Possible Explanation by Kosterlitz-Thouless

\[ T_{KT} \]

\[ T_{MF} \]

\[ \Phi \]

\[ \text{vortex density} \]

\[ \text{spontaneous vortex-antivortex generation} \]

For $H_c$, it seems that underdoped sample has much larger critical field than overdoped samples.

Thus underdop sample seems to have higher pin binding energy. But low doping concentration makes phase slip easier, hence earlier onset of $T_c$. 

\[ T_{c, MF} \]
Since resistivity does not distinguish between vortex and pair condensate, it is a poor probe of \( H_0 \).