

# STRING THEORY & CMP

D.M. WITH:

J. HERZANUS

a) SPIN DUAL OF FQHE

b) HIGH  $T_c$  SUPERCOND.

V. JEDRALA, J. NG & C. TZE

c) TURBULENCE

M. PREIMLING

d) ADS/CFT & AGING

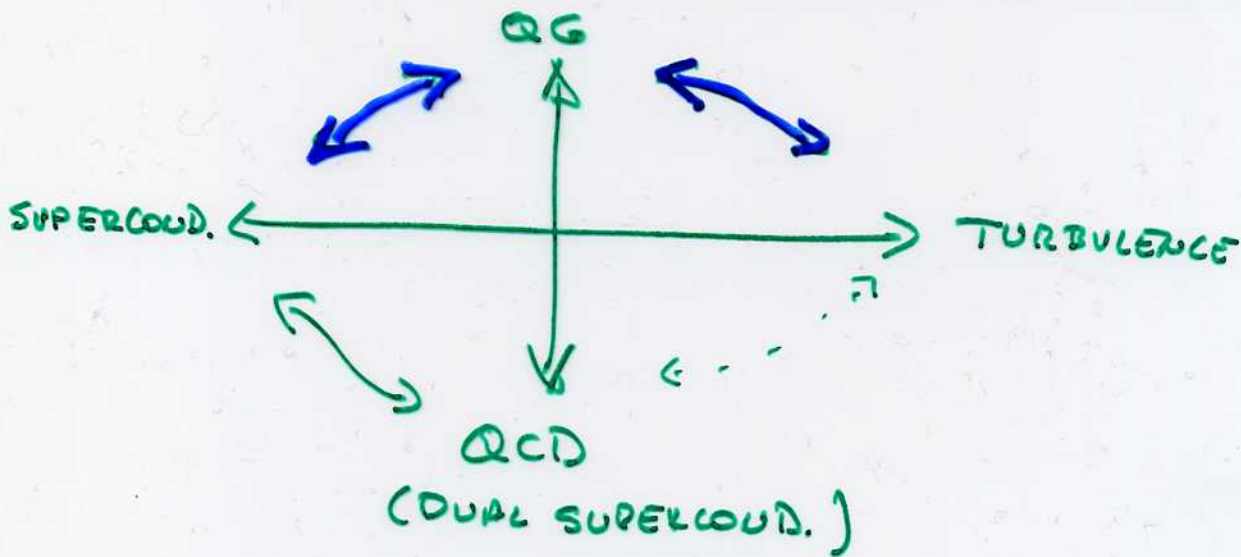
R.G. LEISER, A. MAURI, A. PETKOV

e) ENTROPY OF MEMBRANES  
: (NON-ABELIAN WILSON-FUNNY)  
E-EXPANSION

I WILL TALK ABOUT QUANTUM & CLASSICAL  
FLUIDS ( b, c  $\rightarrow$  e )

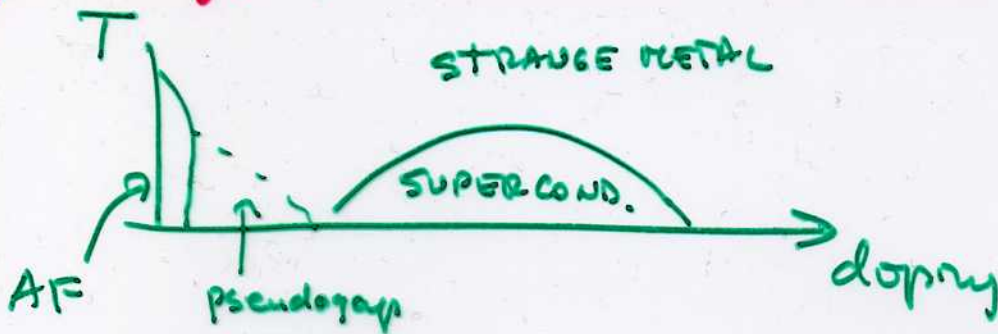
# WHY STRING THEORY & (STRONGLY INTERACTING) FLUIDS?

- a) SYMMETRY: VOLUME PRESERVING DIFFEOS
- b) EXCITATIONS: VORTICES  $\emptyset$
- c) COLLECTIVE FIELDS:  $\oint \vec{v} \cdot d\vec{e} \iff \oint \vec{A} \cdot d\vec{r}$



- 1) High  $T_c$  SUPERCONDUCTIVITY & (EFFECTIVE) GRAVITY
- 2) QG AND TURBULENCE

# 1) High $T_c$ SUPERCOND. & GRAVITY



MAGNETISM  $\overset{vs.}{\longleftrightarrow}$  SUPERCOND.

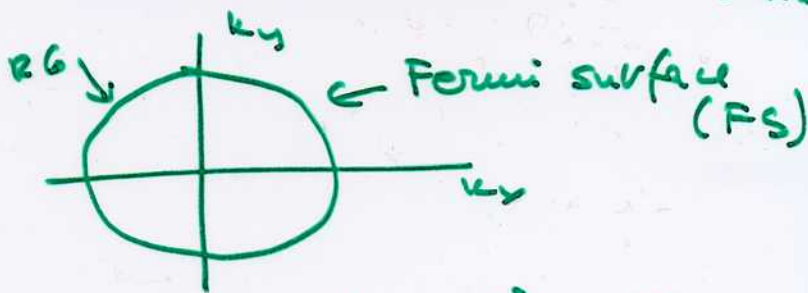
NORMAL STATE (STRANGE METAL): NON-FERMI LIQUID

LANDAU'S EFT OF FERMI LIQUIDS: (POLCHINSKI SHANKAR)

$$\vec{p} = \vec{k} + \vec{e}$$

$$|\vec{k}| = k_F; \vec{e} \perp FS$$

$$E \rightarrow sE; \vec{k} \rightarrow \vec{k}; \vec{e} \rightarrow s\vec{e} \quad (RG \text{ SCALING})$$



$$\int \mathcal{L}_{FL} = \int dt d^3p \left[ i\psi \partial_t \psi - \underbrace{(\epsilon(\vec{p}) - E_F)}_{\epsilon \partial_{\vec{p}} E + \dots} \psi^* \psi \right]$$

$$E \rightarrow sE \Rightarrow t \rightarrow s^{-1}t \Rightarrow \boxed{\psi \rightarrow s^{-1/2} \psi}$$

$$\hookrightarrow \langle \bar{\psi} \psi \rangle \sim \frac{1}{s} \epsilon \text{ SINGLE POLE!}$$

INTERACTIONS & REASON FOR SUPERCONDUCTIVITY

$$\Psi_{P_1, P_2, P_3, P_4} U(P_1, P_2, P_3, P_4)$$

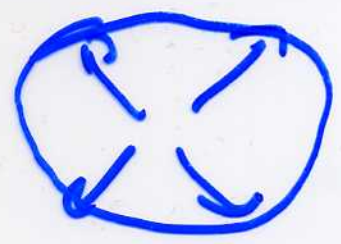
=>  $S^{-1+4-} \xrightarrow{\text{time}} \xrightarrow{e_i} \xrightarrow{\psi} S^1$  => IRRELEVANT EXCEPT WITTEL

$$\delta(\bar{P}_1 + \bar{P}_2 + \bar{P}_3 + \bar{P}_4) = \delta(\bar{k}_1 + \bar{k}_2 + \bar{k}_3 + \bar{k}_4 + \bar{e}_1 + \bar{e}_2 + \bar{e}_3 + \bar{e}_4)$$

(TOMONAGA - LUTTINGER)

a)  $d=1$  NO  $\bar{k}_s$  !!

b)  $\bar{k}_1 + \bar{k}_2 + \bar{k}_3 + \bar{k}_4 = 0$   
COOPER  
 (PAIRING !!)



$\delta(rse) = s^{-1} \delta(r) => \underline{S^0} => \text{MARGINALLY RELEVANT}$

Now,  $\beta$ -function for  $U$  (asymptotic freedom if  $U$  ATTRACTIVE!)

(BCS) => STRONG IN IR BOUND (COOPER) STATES =>  $\Delta$  GAP

$$E = \sqrt{\Delta^2 + \vec{k}^2}$$

$\Delta \sim m$

