Title: Are non-Fermi-liquids stable to pairing?

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Abstract:  $\langle span \rangle$ States of matter with a sharp Fermi-surface but no well-defined Landau $\langle br \rangle$  quasiparticles are expected to arise in a number of physical systems. $\langle br \rangle$  Examples include i) quantum critical points associated with the onset $\langle br \rangle$  of order in metals, ii) the spinon Fermi-surface (U(1) spin-liquid) $\langle br \rangle$  state of a Mott insulator and iii) the Halperin-Lee-Read composite $\langle br \rangle$  fermion charge liquid state of a half-filled Landau level. In this $\langle br \rangle$  talk, I will use renormalization group techniques to investigate $\langle br \rangle$  possible instabilities of such non-Fermi-liquids to pairing. I will $\langle br \rangle$  show that for a large class of phase transitions in metals, the $\langle br \rangle$  attractive interaction mediated by order parameter fluctuations always $\langle br \rangle$  leads to a superconducting instability, which preempts the $\langle br \rangle$  non-Fermi-liquid effects. On the other hand, the spinon Fermi-surface $\langle br \rangle$  and the Halperin-Lee-Read states are stable against pairing for a $\langle br \rangle$  sufficiently weak attractive short-range interaction. However, once $\langle br \rangle$  the strength of attraction exceeds a critical value, pairing sets in. $\langle br \rangle$  I will describe the ensuing quantum phase transition between i) the $\langle br \rangle$  U(1) and the Z\_2 spin-liquid states, and ii) the Halperin-Lee-Read and $\langle br \rangle$  Moore-Read states. $\langle span \rangle$ 













## Open questions



• Properties of the paired state:

- is the "superconductor" type I or type II close to the transiton? Likely type I:  $\xi \sim \lambda^2 \gg \lambda$ 

Important consequences for QHE phenomenology

S. A. Parameswaran, S. A. Kivelson, S. L. Sondhi and B. Z. Spivak (2011)

- how does the vortex mass (vison gap) vanish at the pairing transition?

## Conclusion

- · Progress (and new challenges) in understanding critical fermi surface states.
- · First theory of superconducting instability of a QCP in a 2d metal
  - Pairing glue 🖌
  - Quasiparticle destruction
  - Extensions to other types of orders (besides nematic)?
  - Transport (  $\rho \sim T$  )
- First theory of a transition from a U(1) to a Z<sub>2</sub> spin-liquid
- Non-Fermi-liquids beyond gapless boson + Fermi-surface?

## Thank you!