Mott Criticality as The Confinement Transition of A Pseudogap-Mott Metal

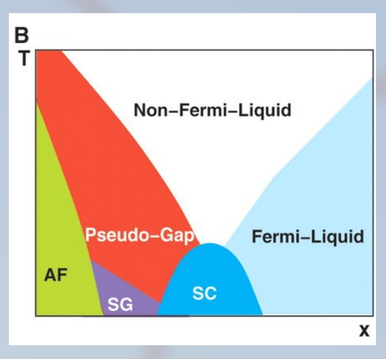
a new auxiliary model approach for correlated electrons

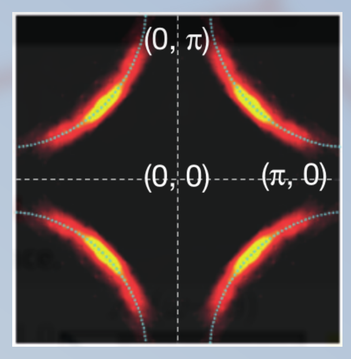
New J. Phys. 28 013503

ABHIRUP MUKHERJEE, S R Hassan, A Mukherjee, N S Vidhyadhiraja, A Taraphder, S Lal

IISER KOLKATA

Challenges: Pseudogap & Strange Metal



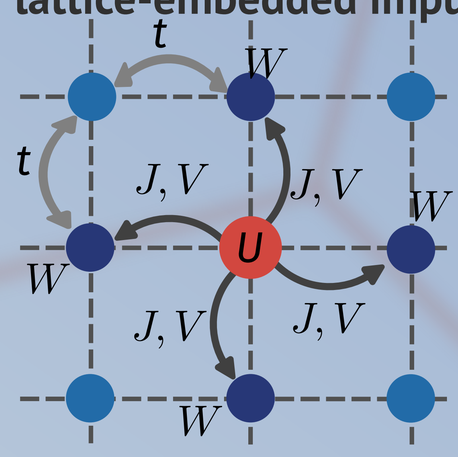


Puzzling experimental observations

- Nature & origin of **pseudogap** and strange metal
- Parent phase of Mott insulator at 1/2–filling ?

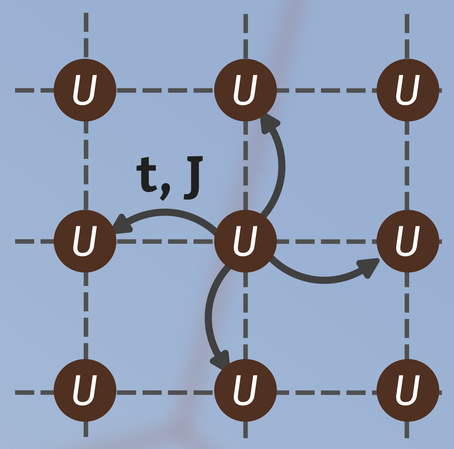
Our Approach, In a Nutshell

lattice-embedded impurity model



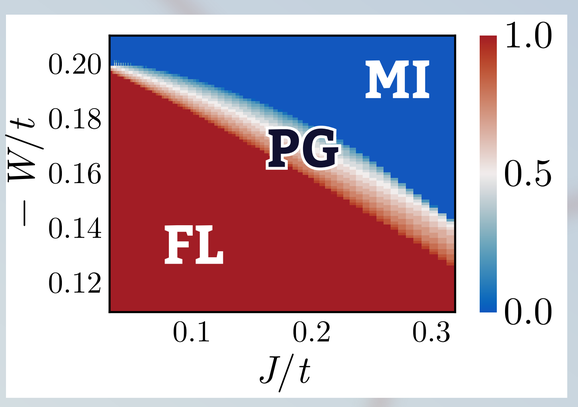
Tiling

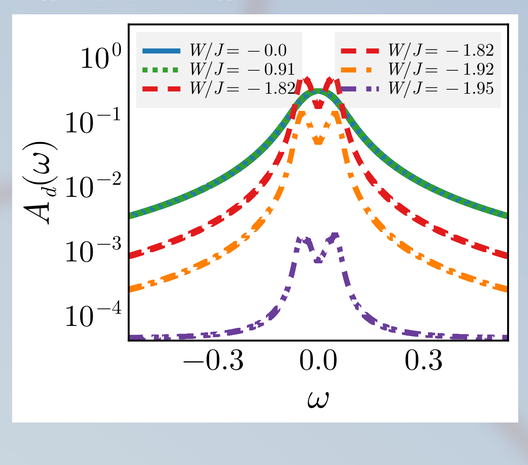
(Manybody translation maps low-energy physics)



2D extended Hubbard model

Phase Diagram & Pseudogapping Transition

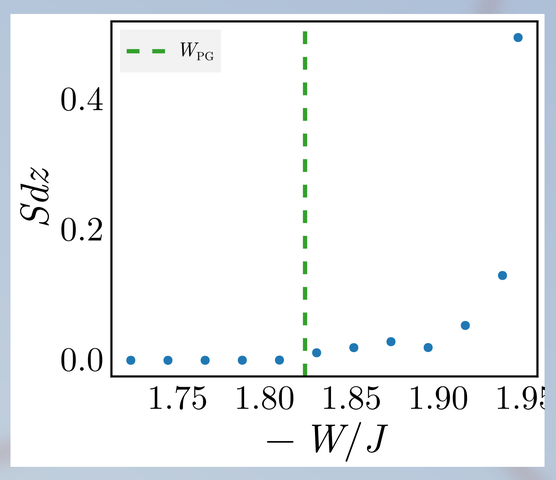


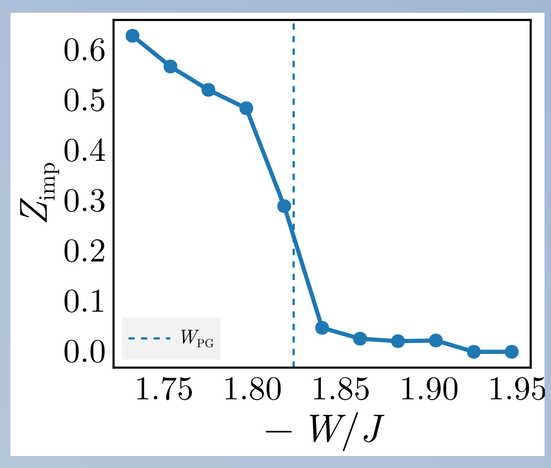


$$\Delta J(k_1, k_2) \sim (J^2 + 4JW)$$

- Competition leads to **Kondo breakdown** for $W < 0$
- pseudogap between Fermi liquid and Mott insulator,
- Impurity spectral function shows **pseudogap** at $\omega = 0$

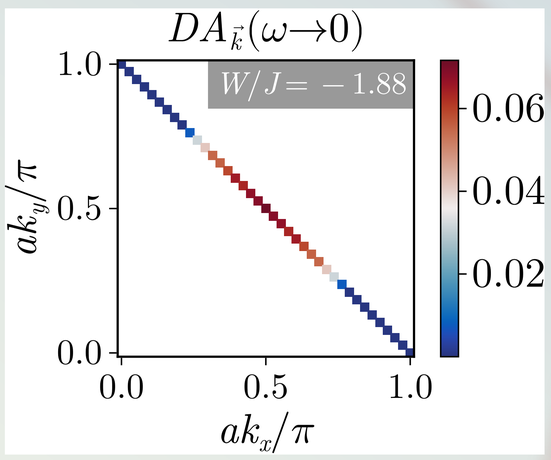
Kondo Breakdown Through the PG

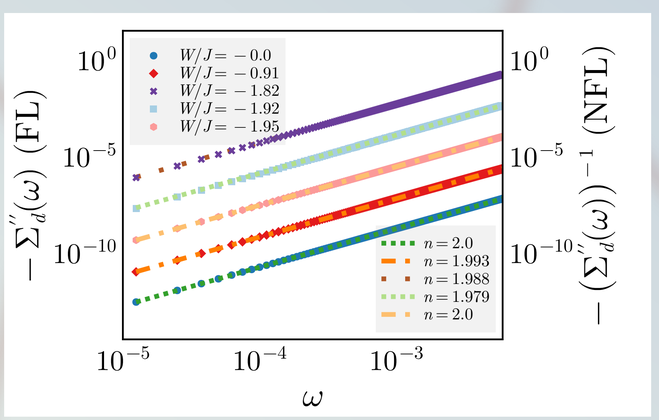




- PG marked by vanishing of **quasiparticle residue**
- Finite magnetisation appears on impurity
- Fixed point theory: long-range **two-channel** Kondo model

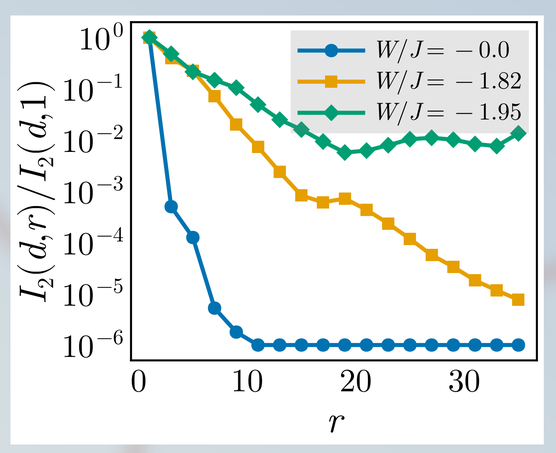
Luttinger Surfaces in the Pseudogap

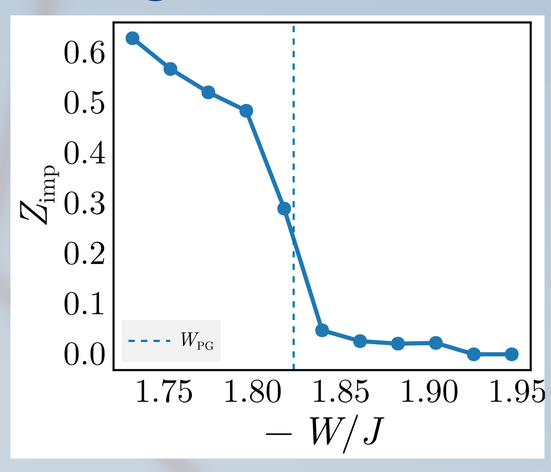




- PG shows **electronic differentiation** in lattice DOS
- Antinodes gapped, nodes gapless
- Robust exponent of 2 in **self-energy**: $1/\Sigma'' \sim 1/\Sigma_0'' + \omega^2$

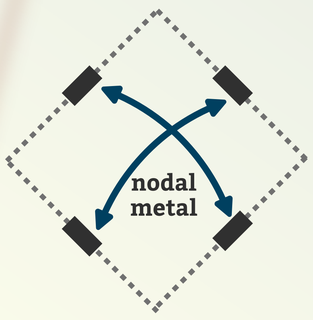
Long-Ranged Entanglement





- real-space correlations and entanglement becomes **long-ranged** in the pseudogap
- Quantum Fisher information shows a jump in **multipartite entanglement** of 2 in FL to 5 within PG.

Singular Nodal Metal at Critical Point



Nodal non-Fermi liquid described by **Hatsugai-Kohmoto model**

$$\sum_{k,\sigma} \varepsilon_k n_{k\sigma} + U \sum_k n_{k\uparrow} n_{k\downarrow}$$

deconfined **holon-doublon** excitations

Main Takeaways

- Realisation of Mott's vision with deconfined holes & doubles
- new phase of strongly interacting quantum matter
- noisy, incoherent environment for electrons

Acknowledgements

AM thanks IISER Kolkata for funding via JRF/SRF. SL thanks SERB for funding through MATRICS and Core Research Grants.