

Abhirup Mukherjee | Research Statement

I am a quantum condensed matter theorist focusing primarily on strongly correlated electron systems. My interests lie in the study of **quantum matter** - novel phases that appear at zero temperature and display emergent exotic properties, often driven by strong interactions between the constituent particles. Examples of quantum matter include (i) the mysterious strange metal and pseudogap phases observed in the cuprates, (ii) spin liquids arising from spin systems that do not order even at zero temperatures, and (iii) fractional quantum hall states that show quantisation of Hall conductivity along robust plateaus. Such phases are interesting because they cannot be organised according to the paradigm of spontaneous symmetry breaking. Instead, phase transitions involving such phases often involve changes in **topology**. This presents a challenge (and therefore opportunities) to extend the “standard model” of condensed matter physics to accommodate such exotic phases.

Kondo breakdown as a route to understanding Mott transitions

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Engineering non-Fermi liquids through critical phases in impurity models

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Bulk-boundary correspondence via entanglement renormalisation in free fermions

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References

- [1] A. Mukherjee, S. R. Hassan, A. Mukherjee, N. S. Vidhyadhiraja, A. Taraphder, and S. Lal, Mott Criticality as the Confinement Transition of a Pseudogap-Mott Metal, (2025).
- [2] A. K. N M, S. Mukherjee, A. Mukherjee, A. Punjal, S. Purwar, T. Setti, S. Prabhu S., S. Lal, and N. Kamaraju, Revealing the magnetic dimensional crossover in the Heisenberg ferromagnet CrSiTe_3 through picosecond strain pulses, Phys. Rev. B **111**, L140414 (2025).
- [3] A. Mukherjee, S. Patra, and S. Lal, Holographic entanglement renormalisation for fermionic quantum matter, Journal of Physics A: Mathematical and Theoretical **57**, 275401 (2024).
- [4] A. Mukherjee, N. S. Vidhyadhiraja, A. Taraphder, and S. Lal, Kondo frustration via charge fluctuations: a route to Mott localisation, New Journal of Physics **25**, 113011 (2023).
- [5] S. Patra, A. Mukherjee, A. Mukherjee, N. S. Vidhyadhiraja, A. Taraphder, and S. Lal, Frustration shapes multi-channel Kondo physics: a star graph perspective, Journal of Physics: Condensed Matter **35**, 315601 (2023).
- [6] A. Mukherjee, A. Mukherjee, N. S. Vidhyadhiraja, A. Taraphder, and S. Lal, Unveiling the Kondo cloud: Unitary renormalization-group study of the Kondo model, Phys. Rev. B **105**, 85119 (2022).