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Lecture 3: Ultra-cold atoms: an ideal toolbox to study transport phenomena

Ultra-cold atoms loaded into artificial optical lattices are ideal systems to study several phenomena that are difficult to probe in the solid state. The reason is because their interaction strength, type and density can be easily controlled in experiments. I will discuss interesting non-equilibrium phenomena that emerge due to the competition between correlation and statistics, and which bear close resemblance with nanoscale systems [1], but which are more difficult to probe in the latter case. In particular, I will discuss non-classical flow patterns of Fermi gases [2], dynamical conducting-nonconducting transitions [3], negative temperatures and current instabilities [4], superfluid to Mott-insulator transition controlled by artificial gauge fields [5], and dynamically generated flat-band phases in optical kagome lattices [6].

References

[1] M. Di Ventra, *Electrical transport in nanoscale systems*, (Cambridge University Press, 2008).
[2] M. Beria, Y. Iqbal, M. Di Ventra, and M. Mueller, Phys. Rev. A, **88**, 043611.
[3] C.-C. Chien, D. Gruss, M. Di Ventra, and M. Zwolak, New J. Phys. **15**, 063026 (2013).
[4] S. Peotta and M. Di Ventra, Phys. Rev. A, **89**, 013621 (2014).
[5] S. Peotta, C.-C. Chien, and M. Di Ventra, arxiv:1405.4246
[6] G.W. Chern, C.-C. Chien and M. Di Ventra, arXiv:1307.6128