Quantum gas microscopy of spatial correlations in attractive and repulsive Fermi-Hubbard systems

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Quantum gas microscopes have taken the study of Hubbard physics in optical lattices to a new level, enabling site-resolved detection of strongly correlated states like Mott insulators and antiferromagnets. We present two experiments using a lithium-6 quantum gas microscope to study the Hubbard model in new regimes. In a first experiment, we investigate the spin correlations of the repulsive Hubbard model in the presence of spin-imbalance [1]. We observe short-range canted antiferromagnetism by measuring the anisotropy of spin correlations in two bases. In addition we find non-monotonic behavior of the spin polarization with doping resembling the behavior of the magnetic susceptibility in the cuprates.

In another experiment, we observe charge density wave correlations in the attractive Hubbard model at half filling [2]. These correlations provide a low-temperature thermometer for the attractive Hubbard model and constitute a lower bound on superfluid correlations in this system.

Our measurements on Fermi-Hubbard physics in the presence of spin-imbalance and doping challenge state-of-the-art numerical methods and contribute to the understanding of the low-temperature physics in these systems. The combination of spin-imbalance with attractive interactions will enable the search for signatures of non-zero momentum superfluids using quantum gas microscopy.

References

[1] P. T. Brown, D. Mitra, E. Guardado-Sanchez, P. Schauss, S. S. Kondov, E. Khatami, T. Paiva, N. Trivedi, D. A. Huse, and W. S. Bakr, arXiv:1612.07746 (2016)
[2] D. Mitra, P. T. Brown, E. Guardado-Sanchez, S. S. Kondov, T. Devakul, D. A. Huse, P. Schauss, and W. S. Bakr, in preparation.

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