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String patterns and machine learning: probing the Fermi-Hubbard model with cold atoms

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Cold atoms provide a versatile platform to study quantum many-body physics from a new perspective. They enable insights into systems that are challenging to describe theoretically and at the same time difficult to realize with a comparable amount of isolation, control, and tunability in solid state systems. The possibilities of cold atom experiments and quantum gas microscopy in particular pose a new opportunity and challenge for theorists to study novel observables that are now accessible. Recently, we have seen dramatic progress in the quantum simulation of the Fermi-Hubbard model, which in 2D is believed to capture essential features of high-temperature cuprate superconductors. In this talk I will present our recent work on the doped Fermi-Hubbard model. We study two-point spin correlation functions as well as less conventional higher order correlations relative to a dopant, which are not directly accessible in solid state experiments. Motivated by an intuitive picture of the motion of the dopant in the spin background, we search for string patterns in single snapshots taken with a quantum gas microscope. For an unbiased comparison of theories and experiment, we apply machine learning to classify experimental data at finite doping into different theoretical categories in order to determine which theory describes the system best on the microscopic level.