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Correlations and Entanglement in Microscopic Samples of Ultracold Fermions

Tuesday, 29 June 2021 11:00 (30 minutes)

Ultracold gases are synthetic quantum systems that are exceptionally well suited for the study of strongly interacting fermions.On the one hand, ultracold Fermi gases naturally exhibit pairing,superfluidity and collective excitations known from solid state physics. On the other hand, their implementation in the laboratory allows microscopically resolved observations down to the single-particle level.This combination enables the application of concepts from quantum information theory to condensed matter-like systems. In this talk, I will discuss our recent experimental progress in detecting correlations and entanglement in fermionic few-body systems realized with Lithium 6 in optical tweezers. Using the AMO toolbox, systems with deterministically controlled particle number can be prepared in a specific quantum state and be interrogated through single particle-resolved imaging in momentum space. I will discuss how such probes can reveal coherences and entanglement in a simple dimer through a reconstruction of the density matrix. In our most recent experiments, we have achieved full control over systems with more than ten particles in two dimensions, where methods based on the density matrix are no longer tractable. I will discuss ideas on how to detect and interpret correlations for such challenging system sizes.

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