Q 1: Ultracold Matter I – Fermions (joint session Q/A)

Time: Monday 11:45–13:00 Location: P 2

Q 1.1 Mon 11:45 P 2

Reduction of pair correlations below the background value in ultracold Fermi gases — •Nikolai Kaschewski[1], Axel Pelster[1], and Carlos A. R. Sá de Melo[2] — [1]University of Kaiserslautern-Landau, Kaiserslautern, Germany — [2]Georgia Institute of Technology, Atlanta, Georgia, USA

For cold atomic gases in the superfluid state, Quantum Monte Carlos (QMC) methods predicted already two decades ago that the anomalous pair correlation function in 3D drops below the uncorrelated background value of one for intermediate distances [1]. Recent progress in developing continuous quantum gas microscopes [2-4] allowed to directly measure pair correlations in 2D [5], confirming this prediction. Although this has sparked new interest into this phenomenon, it lacks until now an analytic explanation.

Against this background, we study two-particle correlation functions in two-dimensional Fermi gases at zero temperature. By allowing the order parameter to adjust to local perturbations, we self-consistently predict a drop of pair correlations below unity, agreeing well with QMC calculations [1] and measurements [5] for weak interactions. The results provide an analytic explanation for the experimentally observed dip based on coupling the density response to induced collective modes, mediating interactions between Cooper pairs. [1] C. Lobo et al., Phys. Rev. Lett. 97, 100405 (2006) [2] J. Xiang et al., Phys. Rev. Lett. 134, 183401 (2025) [3] R. Yao et al., Phys. Rev. Lett. 134, 183402 (2025) [4] T. de Jong et al., Phys. Rev. Lett. 134, 183403 (2025) [5] C. Daix et al., arXiv:2504.01886 (2025)

Q 1.2 Mon 12:00 P 2

Developing a programmable quantum gas microscope — •Sarah Waddington[1,2], Saumya Shah[1,2], Isabelle Safa[1,2], Constanze Vogel[1,2], Rodrigo Rosa-Medina[1,2], and Julian Léonard[1,2] — [1]Institute of Science and Technology Austria (ISTA), Am Campus 1, 3400 Klosterneuburg, Austria — [2]Atominstitut TU Wien, Stadionallee 2, 1020 Wien, Austria

Ultracold atoms in optical lattices offer a versatile platform for simulating and probing strongly correlated quantum matter. While quantum gas microscopy techniques have enabled single-site resolution, key remaining challenges of the field are still posed by rigid lattice configurations and slow cycle times. Here, we present an update on the development of our new quantum gas microscope for fermionic and bosonic lithium atoms. Our approach relies on atom-by-atom assembly in small lattice systems by means of auxiliary optical tweezers, combined with all-optical cooling techniques to facilitate sub-second experimental cycles. The holographic projection of a blue-detuned, short-spacing lattice will provide reconfigurability and fast tunneling dynamics, leading to diverse research avenues for our new project, from the simulation of Bose- and Fermi-Hubbard models with unconventional geometries to strongly correlated topological phases.

Q 1.3 Mon 12:15 P 2

Nonequilibrium correlations in the transverse field Ising model under resonant periodic driving — •Larissa Schwarz[1], Simon Balthasar Jäger[2], Imke Schneider[1], and Sebastian Eggert[1] — [1]University of Kaiserslautern-Landau — [2]University of Bonn

We study the non-equilibrium dynamics of the one-dimensional transverse field Ising model under periodic driving. Using Floquet theory, we derive the steady states of the driven model for a fixed driving amplitude and identify Floquet modes that emerge from strong resonant dressing of the eigenstates of the undriven system. Studying the real time evolution and comparing it with Floquet theory, we find that the system evolves into superpositions of Floquet states, where the ramping rate of the driving amplitude influences the occupation of higher Floquet bands. This behaviour is compared to analytical predictions from a modified Landau-Zener theory. We also compute the two-point correlation functions, which show oscillations in position space that can be tuned with the driving frequency. Our results highlight how periodic driving can be used to create exotic non-equilibrium states.

Q 1.4 Mon 12:30 P 2

Programmable Assembly of Ground State Fermionic Tweezer Arrays — •Marcus Culemann[1], Francesco Testi[1], Jin Zhang[1], Naman Jain[1], and Philipp Preiss[1,2] — [1]Max-Planck Institute of Quantum Optics, Garching, Germany — [2]Munich Center for Quantum Science and Technology, Munich, Germany

Quantum simulation with ultracold fermions in optical lattices provides unique insights into the microscopic details of strongly interacting quantum many-body systems. For non-equilibrium experiments, the choice of the initial atomic configuration is usually limited to a small set of accessible states such as Mott-insulators or charge density waves. Arrays of optical tweezers offer a capable extension to this toolbox by using their dynamic reconfigurability to assemble quantum systems in an optical lattice atom-by-atom.

We demonstrate the preparation of arbitrary spin- and density-resolved product states of single atoms within an 8x8 optical tweezer array. Specifically, we showcase preparation of anti-ferromagnets with engineered defects like domain-walls in the tweezer array and report on recent progress on the state assembly in the lattice. Combined with fast single-exposure spin- and site-resolved imaging, these advancements enable new directions in out-of-equilibrium physics within the Fermi-Hubbard model as well as fermionic quantum information processing.

Q 1.5 Mon 12:45 P 2

Probing Choi superconductivity in a fermionic quantum simulator — •Marnix Barendregt[1,2], Si Wang[1,2], Petar Bojovic[1,2], Johannes Obermeyer[1,2], Dorothee Tell[1,2], Immanuel Bloch[1,2,3], and Titus Franz[1,2] — [1]Max Planck Institute of Quantum Optics, Garching, Germany — [2]Munich Center for Quantum Science and Technology, Munich, Germany — [3]Ludwig Maximilian University of Munich, Munich, Germany

Ultracold fermionic atoms in optical lattices have become a powerful platform for exploring the Fermi-Hubbard model with site-resolved resolution. Many strongly correlated phases exhibit spontaneous strong-to-weak symmetry breaking, but detecting this experimentally is challenging because its signature depends quadratically on the system's density matrix, requiring two identical copies of the state. Here, we introduce an alternative approach based on the Choi doubled Hilbert space representation, where the second copy is generated numerically on a classical computer. In this framework, the Rényi-2 correlator maps onto a superconducting pairing correlator. We probe this "Choi superconductivity" by measuring site-resolved occupation numbers in a lithium-6 quantum gas microscope. These measurements open new avenues for using quantum gas microscopes to identify strongly correlated phases such as Dirac spin liquids and 1+1D conformal field-theory states.