

Microscopy of Density-Wave Ordering in Strongly Interacting Fermi Gases

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With this poster, I will present our investigation on the emergence of density wave order in a degenerate Fermi gas strongly coupled to the electromagnetic field of a high-finesse cavity [1,2]. This ordered state simultaneously exhibits superradiance in the cavity field and self-organisation of the atoms into a crystalline lattice [3]. Our experimental setup combines real-time monitoring of the cavity field with high-resolution microscopy over the atomic cloud. With this last capability, we achieve the first direct, in situ imaging of the periodic modulation of the charge-density waves. These observations enable the reconstruction of correlations between photonic and atomic signatures in the formation of the phase transition and provide new insights into the ordering process, opening new avenues for the investigation of light-induced phase transition in fermionic systems.

[1] Roux, H., Helson, V. K., Konishi and Brantut J.P. Cavity-assisted preparation and detection of a unitary Fermi gas, *New J. Phys.*, 23, 043029.

[2] Roux K., Konishi H., Helson V. and Brantut J.P., Strongly correlated Fermions strongly coupled to light, *Nat Commun* 11, 2974 (2020).

[3] Helson, V., Zwettler, T., Mivehvar, F. et al. Density-wave ordering in a unitary Fermi gas with photon-mediated interactions, *Nature* 618, 716-720 (2023).