Cavity QED with Strongly Interacting Fermions

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Quantum-degenerate atomic gases represent paradigmatic systems for the study of many-body and fundamental physics applications, as extreme quantum conditions can be engineered with remarkably high precision. In our experiment, we combine a quantum degenerate, strongly interacting Fermi gas of Lithium 6 with a high-finesse optical cavity [1–3], greatly enhancing the atom-photon coupling.

By driving the cavity in the dispersive regime, we observe a Kerr non-linearity originating from the optomechanical coupling of photons with the density fluctuations of the strongly interacting Fermi gas. I will report on the measurement of this non-linearity as a function of interaction strength in the BEC-BCS crossover. The connection between the few-photon non-linearity in the cavity and the strength of pair correlations will be discussed, highlighting the potential of cavity QED methods for the investigation of complex, strongly interacting systems.

Furthermore, we recently started exploring the interplay between long range, mediated by photons scattered off an off-axis pump into the cavity, and short range interactions in the gas. As the pump power is increased we observe transitions to superradiant, self-organized, phases accross the BEC-BCS crossover. I will briefly present our preliminary observations on that regard.

References

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