EPFL LQG LABORATORY for QUANTUM GASES

Towards Quantum Simulation of Random Spin Models

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Models of interacting Fermions are ubiquitous in condensed matter and high-energy physics. Of particular interest are models with long-range and all-to-all interactions, such as the SYK model, which is relevant to holographic duality. We are developing a cold atom experiment aimed at realizing ultra-cold Fermi gases with long-range, programmable interactions induced using cavity quantum-electrodynamics methods.

The core of our experiment is a cold gas of Lithium atoms in an optical system realizing both a high-finesse cavity and a high-numerical-aperture lens combined in a single optical element. The cavity can be used to induce photon-exchange interactions between atoms. A second short-wavelength laser, tightly focused onto the Lithium atom cloud, leads to a local light-shift of the atomic transition coupled to the cavity. This can allow for a spatial and temporal control over the cavity-mediated interactions and can additionally be used for super-resolved measurements of the atomic position [1].

Currently, we have assembled the system and managed to control the coupling of the atoms to the cavity by light-shifting their transition frequency. The presentation discusses the design, the status of the setup and outlines possible future experiments in the search for new physics.

[1] Yang, D., et al., PRL 120, 133601, (2018)