Disordered optical potentials for strongly correlated lithium-6 gases

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Ultracold atoms and quantum gases offer an ideal playground to study phenomena otherwise difficult to approach in many fields of research, as in such systems the strength of interactions, the dimensionality and the trapping geometry can be precisely adjusted. We present the realization of tunable disordered optical potentials with a Digital Micromirror Device (DMD) and our current work in the realization of a two-dimensional (2D) strongly interacting Fermi gas. The DMD is a reflective Spatial Light Modulator (SLM), through which arbitrary light patterns can be created. We focused our attention in creating disordered light pattern demonstrating the capability of such device, together with a high-resolution optical system, to create both speckles and point-like disorder, with a characteristic length of the order of a micron. In order to imprint on the atomic cloud the DMD-made optical potentials and to improve the imaging resolution, we implemented a new high-resolution achromatic objective, that allows for a resolution below the micrometer scale. Such objective is used to both image the atoms with resonant light, and to imprint blue-detuned optical potentials on the atomic cloud. The performances of the objective have been characterized using an optical target, and here we present our results. Finally, we present the outlook of our experiment: the study of a 2D strongly-correlated Fermi gas. As a first step, we plan to use transport measurement to characterize the superfluid phase in 2D and unambiguosly probe the BKT transition. We then will study coherent dynamic and dissipation effects of the superfluid in the Landauer paradigm and in a Josephson geometry. Finally, we will introduce controllable disorder and characterize the behaviour of the superfluid in the BEC-BCS crossover in the presence of tunable point-like disorder.