Spontaneous density-modulation through Rydberg dressing: Cluster Gutzwiller mean-field study of a Bose-Hubbard model with non-local interaction MATHIEU BARBIER, JAROMIR PANAS, WALTER HOFSTETTER, Goethe Universität Frankfurt am Main — Recently it became possible to experimentally create macrodimers in a lattice through coupling of an ultracold bosonic quantum gas to high lying Rydberg states [1]. As a follow-up study, it was proposed to use the coupling to macrodimer states for the enhancement of Rydberg dressing schemes, which might lead to a rich phase diagram of non-trivial quantum phases. We theoretically study a bosonic quantum gas trapped in an optical lattice with weak Rydberg dressing, resulting in an effective next-nearest neighbor interaction. In this work we consider both attractive and repulsive interaction. In order to capture additional quantum fluctuations and the expected broken translational symmetry, we treat the system with the Cluster Gutzwiller method [2]. We find various quantum phases, such as Mott insulating and superfluid phases as well as density wave phases between the Mott lobes that are stabilized by hopping processes. We propose how to access these phases with a range of experimentally feasible parameters.
[1] S. Hollerith et al., Science 364, 664 (2019)
[2] D. Lühmann, Phys. Rev. A 87, 043619 (2013)

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