Magnetic phases for spinor bosons in the cavity

Maksym Prodius,[1,2,*] Mateusz Łacki,[2] and Jakub Zakrzewski[2,3]

[1] *Szkoła Doktorska Nauk Ścisłych i Przyrodniczych, Uniwersytet Jagielloński, ulica Stanisława Łojasiewicza 11, PL-30-348 Kraków, Poland*
[2] *Instytut Fizyki Teoretycznej, Wydział Fizyki, Astronomii i Informatyki Stosowanej, Uniwersytet Jagielloński, Łojasiewicza 11, PL-30-348 Kraków, Poland*
[3] *Mark Kac Complex Systems Research Center, Jagiellonian University in Kraków, PL-30-348 Kraków, Poland*

As experimental trapping of ultracold spinor bosonic gases in high-finesse optical cavities continues to advance, there is a growing need for theoretical studies of the corresponding extended Bose–Hubbard models with two-component bosons. Here, we investigate the simplest case of cavity-induced interactions that arise when the nodes of the optical lattice coincide with the antinodes of the cavity field. We analyze the system within mean-field theory in the grand-canonical ensemble. In the atomic limit, the homogeneous system hosts two insulating magnetic phases: an anti ferromagnet (AFM) and a spin density wave (SDW). When tunneling is introduced, these phases become surrounded by a superfluid phase and three distinct supersolid phases, distinguished by different patterns of spin and density imbalances between odd and even sites. Finally, we include a harmonic trapping potential with a fixed magnetization constraint in our simulations, which allows us to obtain the full phase diagram directly relevant for experiments, reveling plethora of different phases that could be observed in a trap.

* maksym.prodius@doctoral.uj.edu.pl