Ground states of one-dimensional dipolar lattice bosons at unit filling

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In this talk I will exploring possibilities for quantum simulation of extended Hubbard models, focusing on one-dimensional models at unit filling. The dipolar interactions, extending beyond nearest neighbor, are described by effective power-law decay exponent β_{eff}). While normally β_{eff} =3, the dipolar interactions are influenced by transversal confinement allowing to consider β_{eff} =1-3.
Even for β_{eff} =3 the phase diagram already contains phases unobserved under assumption of nearest-neighbor interaction: density waves with longer periods and a novel insulating phase (topologically trivial insulator – TTI).
By adjusting the transversal confinement, a longer tail in Dipolar coefficients decay is achieved (we focus on β_{eff} of 1), enhancing the TTI region and introducing a new TI phase. The TTI phase is between 3DW and Haldane insulator phases, and features interesting correlations of site occupations. Additionally, the TI phase results from the melting of the 4DW phase. Another Mfeature are quantitative changes to the Haldane insulator regime We will discuss possible realization and observability of these phases in state-of-the-art experiments involving ultracold quantum systems in optical lattices.

The main research method is infinite density-matrix renormalization group (iDMRG) calculation of ground-state phase diagrams.

References

[1] Mateusz Łącki, Henning Korbmacher, G. A. Domínguez-Castro, Jakub Zakrzewski, Luis Santos, https://arxiv.org/abs/2311.14606 (2023)

Figures

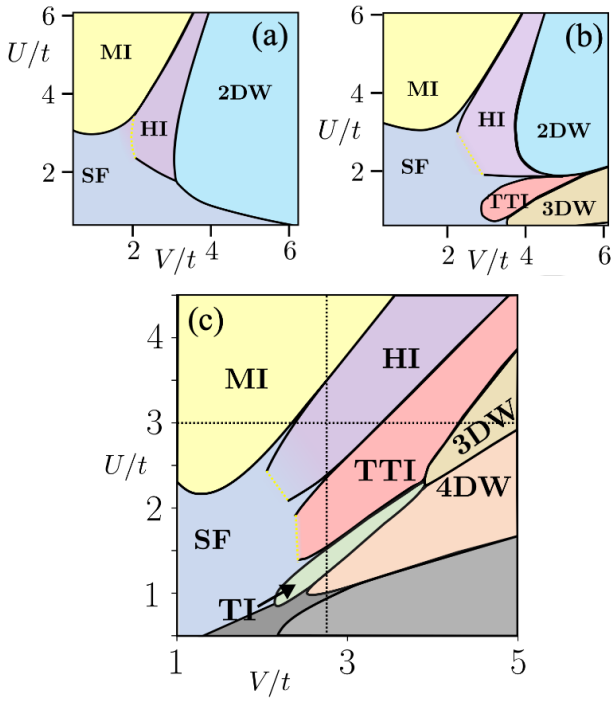

Figure 1: Phase diagrams of Extended Bose-Hubbard model. (a) standard model with nearest-neighbor dipole-dipole Vn_in_{i+1} terms (b) EBH model with V terms beyond nearest neighbor (cubic interaction decay) (c) EBH model with V terms beyond nearest neighbor (β_{eff}=1).