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Momentum-space correlations of lattice Bose gases close to the Mott transition

We study interacting Helium-4 Bose gases in an optical lattice, realising the 3D Bose-Hubbard hamiltonian [1]. This hamiltonian holds a quantum phase transition, from a superlfuid to a Mott insulator, and we report our on-going efforts to characterise many-body correlations in the vicinity of this transition. To this aim, we use a unique experimental probe which consists in detecting metastable Helium-4 atoms one by one after a long time-of-flight to measure atom correlations in momentum space [2]. We have recently exploited this approach to reveal the Bogoliubov pairs of atoms with opposite momenta in the quantum depletion of a weakly interacting Bose gas [3] and to study the high-order correlations (between up to 6 atoms) in lattice superfluids and Mott insulators [4]. Our present efforts rely on these previous studies to quantify momentum correlations close to the Mott transition.

[1] C. Carcy et al. Phys. Rev. Lett. (2020)
[2] H. Cayla et al. Phys. Rev. A (2018)
[3] A. Tenart et al. Nat. Phys. (2021)
[4] G. Hercé et al. Phys. Rev. Research (2023)

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