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Titre : *From Mott insulators to checkerboard solids : Exploring the extended Bose-Hubbard Hamiltonian with dipolar excitons*

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Résumé : *The Hubbard model constitutes one of the most celebrated theoretical frameworks of condensed-matter physics. It describes the collective quantum phases accessible to interacting quantum particles confined in a lattice potential. For bosons, the physics of the Bose-Hubbard model has been deeply studied with ultra-cold atomic vapours held in optical lattices. This has led to important milestones, notably the demonstration of Mott insulating phases, marked be the same integer number of particles in every lattice sites, and the transition from Mott to superfluid regimes. On the other hand, in the solid-state a platform to emulate the Bose-Hubbard model was missing until very recently.*

Here, I report experiments evidencing that semiconductors dipolar excitons of bilayer heterostructures, i.e. made by spatially separated electrons and holes, enable controlled implementations of Bose-Hubbard Hamiltonians. Indeed, state-of-the-art nano-fabrication techniques allow to imprint two-dimensional lattices with on-demand geometries where dipolar excitons are efficiently confined at sub-Kelvin temperatures. For lattices with around 500 nm periods on-site interactions are dominant and excitonic Mott insulators are directly accessed, with either one or two excitons uniformly occupying lattice sites [1]. Remarkably, by further reducing the lattice period to around 200 nm dipolar repulsions between excitons confined in neighbouring lattice sites control the structure of the many-body ground state. Thus, we access the so-called extended Bose-Hubbard Hamiltonian which is directly revealed in our experiments by an incompressible phase at half-filling of the lattice

potential. This signals that excitons realise a checkerboard solid, as quantitatively confirmed theoretically [2].

[1] C. Lagoin et al., Nat. Phys (2021) [2] C. Lagoin et al., arXiv :2201.03311 (2022)