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Quantum phases from competing short- and long-range interactions in an optical lattice LORENZ HRUBY, RENATE LANDIG, NISHANT DOGRA, MANUELE LANDINI, RAFAEL MOTTL, TOBIAS DONNER, TILMAN ESSLINGER, ETH Zurich — Quantum simulations with ultracold atoms are mostly limited to short-range collisional interactions, while longer ranged interactions have proven to be difficult to implement so far. Here we experimentally realize a bosonic lattice model with competing short- and infinite-range interactions, and observe the appearance of four distinct phases - a superfluid, a supersolid, a Mott insulator and a charge density wave. Our system is based on an atomic quantum gas trapped in an optical lattice inside a high finesse optical cavity. The strength of the short-ranged on-site interactions is controlled by means of the optical lattice depth. The infinite-range interaction potential is mediated by a vacuum mode of the cavity and is independently controlled by tuning the cavity resonance.

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