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Quantum Magnetism in an Optical Lattice: Antiferromagnetic Ising Chain in Transverse and Longitudinal Fields WASEEM BAKR, JONATHAN SIMON, RUICHAO MA, ERIC TAI, PHILIPP PREISS, MARKUS GREINER, Harvard University — Understanding the behaviors of strongly-interacting spin systems is one of the central objectives of condensed matter physics. Solid-state realizations of such systems can be quite difficult to control and observe, and do not often admit description with simple models due to their complex structure and myriad interactions and dissipation channels. Ultracold gases in optical lattices offer an elegant alternative, providing exquisite control over interactions, and structure, and recently, site-resolved read-out. Here we present the first realization of quantum magnetism within an optical lattice. Using ultracold Rubidium atoms, we study an Ising spin chain in both transverse and longitudinal fields. By mapping the spin degree of freedom onto dipolar excitations of a Mott Insulator in a tilted optical lattice, we achieve strong spin-spin interactions, and fast dynamics. By sweeping the lattice tilt, we demonstrate a phase-transition from a paramagnetic phase to an anti-ferromagnetic phase. We observe anti-ferromagnetic ordering both *in-situ*, taking advantage of the single-site resolution of our quantum gas microscope, and via a 1D quantum noise correlation measurement.

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