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Observation of entanglement propagation in a quantum many-body system PETAR JURCEVIC, BEN P. LANYON, PHILIPP HAUKE, CORNELIUS HEMPEL, PETER ZOLLER, RAINER BLATT, CHRISTIAN F. ROOS, Institute for Quantum Optics and Quantum Information, Austria — The key to explaining a wide range of quantum phenomena is understanding how entanglement propagates around many-body systems. Furthermore, the controlled distribution of entanglement is of fundamental importance for quantum communication and computation. In many situations, quasiparticles are the carriers of information around a quantum system and are expected to distribute entanglement in a fashion determined by the system interactions. Here we report on the observation of magnon quasiparticle dynamics in a one-dimensional many-body quantum system of trapped ions representing an Ising spin model. Using the ability to tune the effective interaction range, and to prepare and measure the quantum state at the individual particle level, we observe new quasiparticle phenomena. For the first time, we reveal the entanglement distributed by quasiparticles around a many-body system. Second, for long-range interactions we observe the divergence of quasiparticle velocity and breakdown of the light-cone picture that is valid for short-range interactions. Our results will allow experimental studies of a wide range of phenomena and represent a first step towards a new quantum-optical regime with on-demand quasiparticles with tunable non-linear interactions.

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