Abstract: This talk will describe the recent observation of many-body localization (MBL) in a quantum simulator with programmable random disorder. Effective magnetic spins are encoded within the long-coherence-time electronic states of trapped ions, which are measured with nearly perfect efficiency. Tunable, long-range interactions are generated across the entire chain using state-dependent optical dipole forces and benchmarked using a newly-developed spectroscopic technique. To experimentally generate MBL states, we apply tunable, random, site-dependent disorder in the presence of a long-range interacting Ising Hamiltonian. For strong enough disorder, we observe the essential signatures of MBL: memory retention of the initial state, a Poissonian distribution of energy level spacings, and entanglement growth in the system at long times. This trapped-ion platform can be scaled to higher numbers of spins, where detailed modeling of MBL becomes impossible due to the complexity of representing such highly entangled quantum states.