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A macroscopic "order parameter" for many-body localization RONEN VOSK, MARK FISCHER, EHUD ALTMAN, Weizmann Institute of Science, MICHAEL SCHREIBER, SEAN HODGMAN, HENRIK LÜSCHN, PRANJAL BORDIA, ULRICH SCHNEIDER, IMMANUEL BLOCH, Ludwig-Maximilians-Universitat Munchen — Recent theoretical progress in characterizing many-body localized systems has not been confronted so far with an experimental test. Here we present a theoretical analysis of new experimental results showing many-body localization of interacting fermions in a quasi periodic optical lattice potential. Specifically we consider the time evolution of a system prepared in a particular many-body initial state, a charge-density wave. Relaxation of the density-wave to a non-vanishing value at long times provides a direct demonstration of the breakdown of ergodicity in the many-body localized state and the saturation value can serve as an order parameter of this state. We investigate how this order parameter depends on the interaction strength and on the initial state. Moreover, we show how (temporal) fluctuations in this order parameter are connected to the entanglement-entropy growth, thus providing a distinguishing signature that could be observed in future experiments. Finally we propose new experiments that would demonstrate the persistence of local quantum coherence in this system.

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