Representing highly excited eigenstates of many-body localized systems using matrix product states

BRYAN CLARK, Kavli Institute for Theoretical Physics, University of California at Santa Barbara; Physics Department, University of Illinois at Urbana Champaign, DAVID PEKKER, Department of Physics, Caltech; Department of Physics and Astronomy, University of Pittsburgh — Many-body localization remains a mysterious topic largely due to the lack of tools for describing highly excited eigenstates of interacting quantum systems. Matrix Product States (MPS) are a family of low-entanglement variational ansatz. Typically, excited states of many-body systems exhibit volume law scaling of the entanglement entropy and therefore cannot be efficiently described by an MPS of low bond-dimension. In many-body localized systems, though, the eigenstates generically have area law scaling suggesting the existence of an efficient MPS representation. Here we investigate how to find these states. Our achievement opens a new numerical window on many-body localization.