Many-Body Localization Without Disorder

J Zakrzewski[1,2], T Chanda[2], and R Yao[3]

[1]*Mark Kac Complex Systems Research Center, Jagiellonian University, Kraków, Poland*
[2]*Institute of Theoretical Physics, Jagiellonian University, Lojasiewicza 11, 30-348, Kraków, Poland.*
Contact Phone: +48126644555
[3]*Department of Physics, Tsinghua University, Beijing, China*
Contact Email: jakub.zakrzewski@uj.edu.pl

Nonergodic dynamics of interacting spinless fermions in a tilted optical lattice as modeled by XXZ spin chain in magnetic (or electric) field changing linearly across the chain is discussed. The time dynamics is studied using exact propagation (for small chains) and matrix product states techniques (for larger system sizes). Both the initial Néel separable state as well as the quantum quench scenario in which the initial state may be significantly entangled is considered .. In the former a rapid initial growth of entanglement entropy is followed by a saturation for sufficiently large tilt, F. In the latter case the dynamics seems to be dominated by pair tunneling and the effective tunneling rate scales as $1/F^2$. In the presence of an additional harmonic potential the imbalance is found to be entirely determined by a local effective tilt, F_{loc}, the entanglement entropy growth is modulated with frequency that follows $1/F_{loc}^2$ scaling first but at long time the dynamics is determined rather by the curvature of the harmonic potential. The same curvature determines long-time imbalance for large F which reveals strong revival phenomena associated with the manifold of equally spaced states, degenerate in the absence of the harmonic potential.