Family-Vicsek Scaling of Surface-Roughness Dynamics in a One-Dimensional Bose-Hubbard Model

K Fujimoto[1,2], R Hamazaki[3], and Y Kawaguchi[1]

[1]*Applied Physics, Nagoya University, Aichi, Japan*
[2]*Institute for Advanced research, Nagoya University, Aichi, Japan*
[3]*RIKEN, Saitama, Japan*
Contact Email: kazuya_fujimoto@rover.nuap.nagoya-u.ac.jp

Universal nonequilibrium dynamics have been investigated in both classical and quantum systems, and dynamical scaling plays an important role in understanding their universal aspects. Among them, classical surface growth has become a great stage for studying such scaling, and the growing surface-roughness is known to show the Family-Vicsek (FV) scaling. The FV scaling exponents have been investigated using many theoretical models such as the Kardar-Parisi-Zhang (KPZ) equation.

We theoretically study the particle-number fluctuation dynamics in a strongly-interacting Bose-Hubbard model in a one-dimensional system from the perspective of surface-roughness growth originally developed in classical systems. We first introduce a surface-height operator by extending a mathematical analogy between classical fluctuating hydrodynamics and the KPZ equation. Next, using this operator, we study the dynamics of surface roughness, which is defined by the second cumulant of the surface-height operator. Our numerical calculation finds that the surface roughness in the quantum unitary dynamics shows the FV scaling and that the FV scaling exponents depend on the filling factor [1].

References

[1] K Fujimoto, R Hamazaki and Y Kawaguchi, Phys. Rev. Lett. **124**, 210604 (2020)