

HATANO LAB.

Connecting Microscopic and Macroscopic Physics

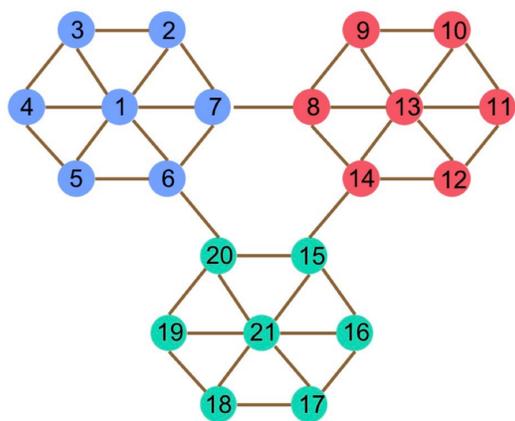
Large-scale experiment and advanced-analysis platform (LEAP)



Quantum Thermodynamics and Statistical Physics

Department of Physics, Graduate School of Science

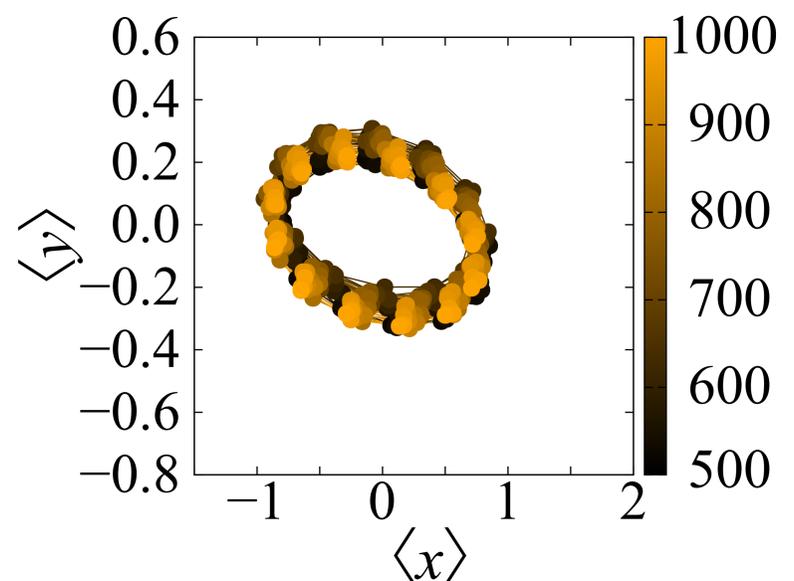
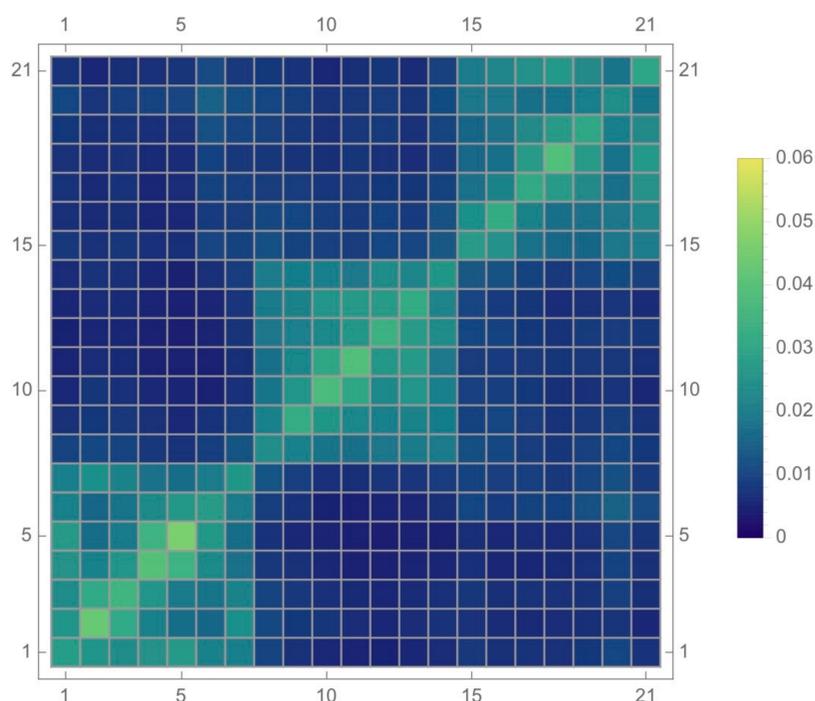
<http://hatano-lab.iis.u-tokyo.ac.jp/>



Networks that surround us can have hubs and communities (a.k.a. clusters). It has been studied intensively as a difficult problem to detect communities from given data of networks.

Our laboratory succeeded in community detection by using a quantum walk, which is a quantum version of a random walk. From a prototypical network on the upper-left figure to the U.S. airport network, we showed a quantum walker is localized in each community; see the figure on the lower left.

(Kanae Mukai and Naomichi Hatano, *Physical Review Research*, Vol. 2, No. 023378, 2020)



Quantum walk is handy to simulate physics in relativistic regions. It was known that the 1D quantum walk is equivalent to a 1D Dirac particle but a 2D quantum walk that is equivalent to a 2D Dirac particle has not been known.

Our laboratory found such a quantum walk for the first time in the world. The 2D model successfully exhibits an elliptic dynamics in a harmonic potential (upper right) and the spectrum of a topological insulator (lower right).

(Manami Yamagishi, Naomichi Hatano, Ken-Ichiro Imura and Hideaki Obuse, *Physical Review A*, Vol. 107, No. 042206, 2023.)

