HATANO LAB.

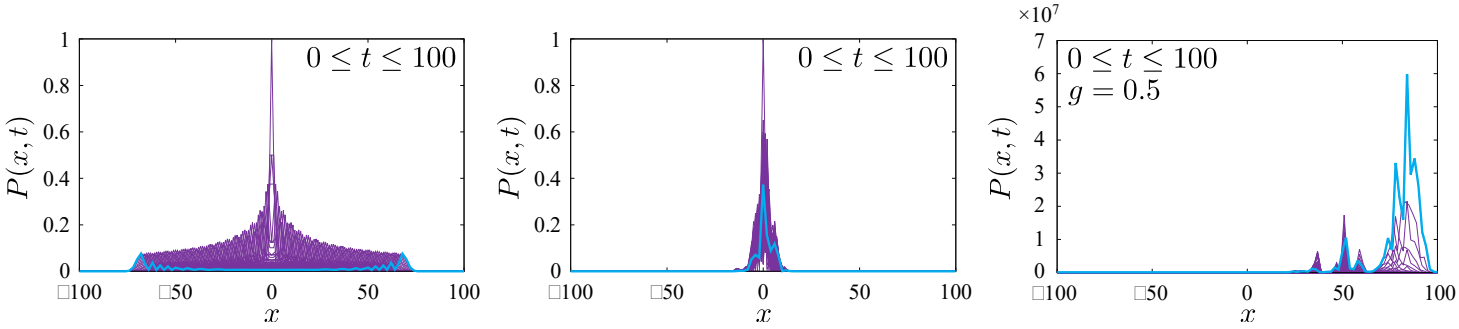
[Quantum Mechanics and its Applications]

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

Quantum Thermodynamics and Statistical Physics

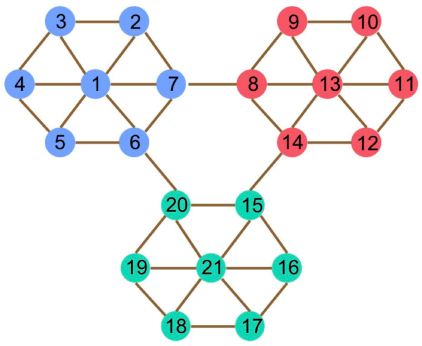
Department of Physics, School of Science

http//hatano-lab.iis.u-tokyo.ac.jp/



Quantum mechanics normally assumes that the energy and other physical observables have a mathematical property called the Hermiticity. The last two decades saw a serge of new studies that extend them to non-Hermitian quantities. Hatano with a collaborator initiated the study of non-Hermitian quantum mechanics in 1996. The system is now known as the Hatano-Nelson model. We found recently that the quantum version of random walk, when extended to a non-Hermitian quantum walk , behaves similarly to the Hatano-Nelson model.

A normal quantum walker has two peaks running to the left and right at an equal speed (left of the above figures). When we introduce imprities, the quantum walker stops running (middel of the above figures). When we further introduce a non-Hermitian field following the Hatano-Nelson model, the walker is swept away to the right (right of the above figures).
(Naomichi Hatano and Hideaki Obuse, Annals of Physics, Vol. 435, No. 168615, 2021)



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 above figure to the U.S. airport network, we showed a quantum walker is localized in each community; see the figure on the right.
(Kanae Mukai and Naomichi Hatano, Physical Review Research, Vol. 2, No. 023378, 2020))