

# HATANO LAB.

## Expanding the Frame of Physics

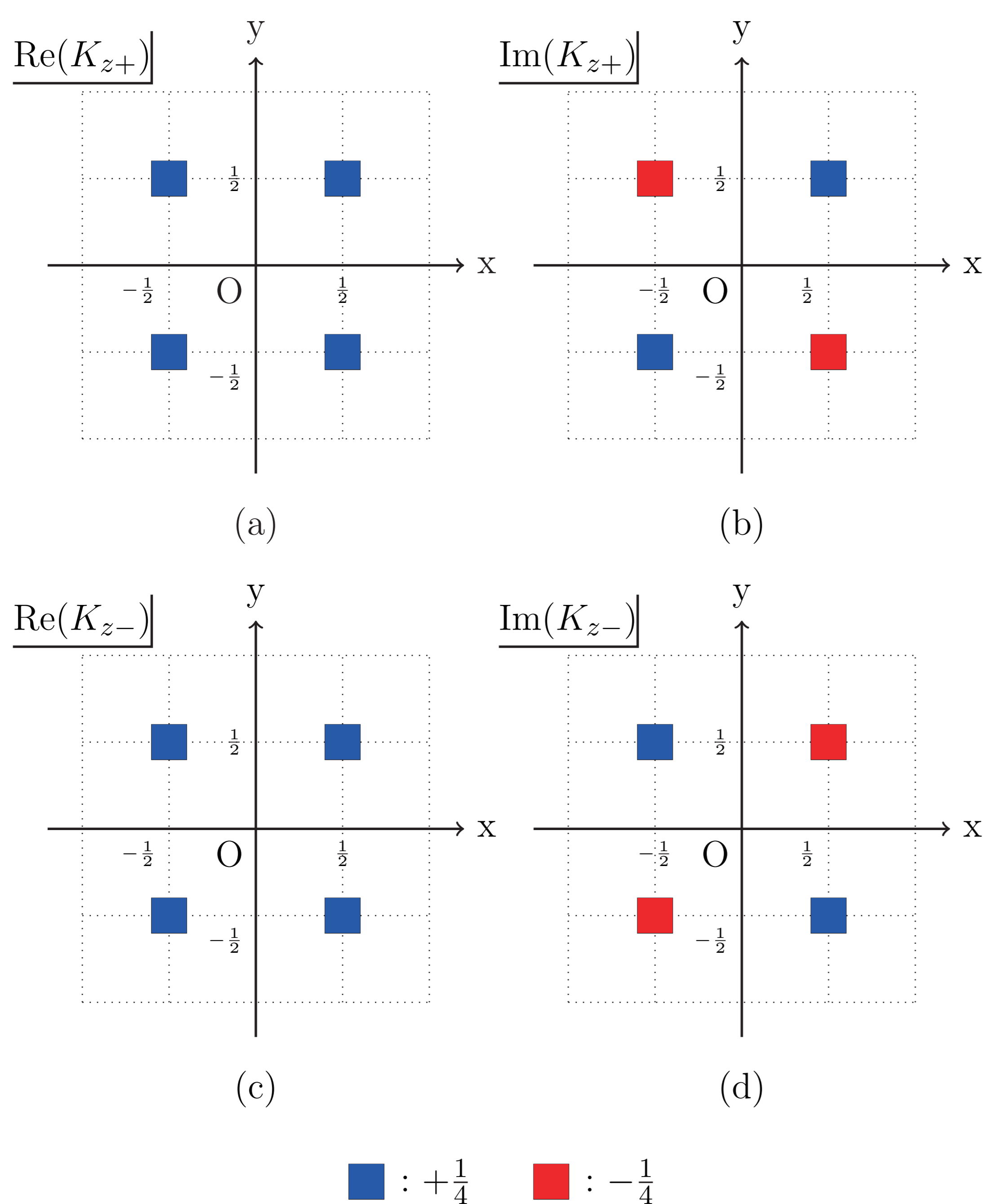


Large-scale experiment and advanced-analysis platform (LEAP)  
Department of Fundamental Engineering

Quantum Thermodynamics and Statistical Physics

Department of Physics, Graduate School of Science

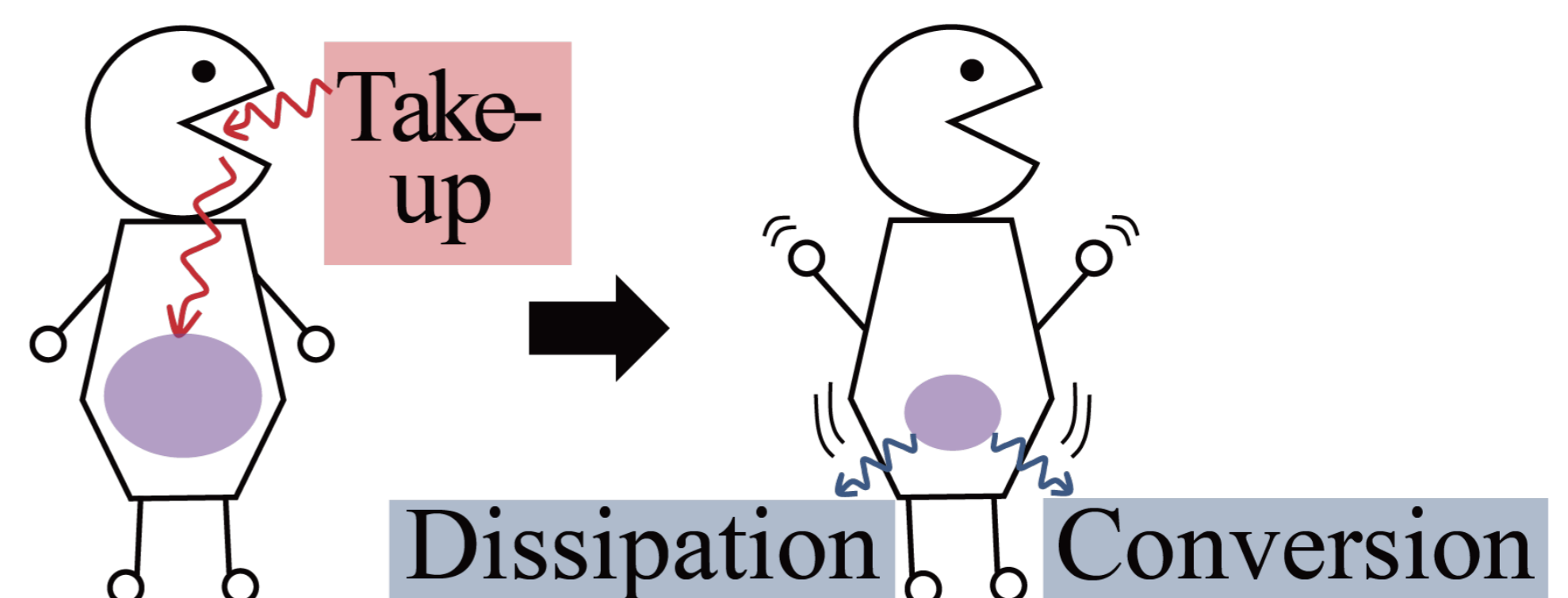
<http://hatano-lab.iis.u-tokyo.ac.jp/>



The uncertainty principle defies joint description of multiple quantum observables. This motivated the introduction of complex-valued ‘quasi-probabilities’ to account for their virtual joint behavior.

Our laboratory proposed several criteria for their usefulness based on a unified theory of quantizations and quasi-probabilities. Among various candidates, the Kirkwood-Dirac distribution (left) is found to be favored in terms of faithfulness and affinity to classical theory.

(Shun Umekawa, Jaeha Lee, and Naomichi Hatano, Prog. Theor. Exp. Phys., Vol. 2024, No 023A02, 2024.)



Active matter is a self-driven component or a collection of such components. Active matter can include lifeless matter as well as living matter, such as birds and fish. From a physical point of view, active matter takes energy from the environment and stores it as internal energy, converts the internal energy into kinetic energy, and thereby moves (upper right).

Our laboratory proposed a model of a quantum version of active particle that has no classical counterpart. We indeed showed that the higher component can climb up a potential more and faster than the lower component of the quantum active particle (lower right). We expect that this is useful in devising an efficient quantum search algorithm.

(Manami Yamagishi, Naomichi Hatano, and Hideaki Obuse, Scientific Reports, Vol. 14, No. 28648, 2024.)

