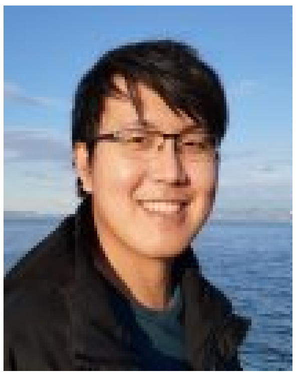
16 Dec Thursday 1:30 – 2:15 Chair: HO Wen Wei (何文维)

Emergence of Quantum State Designs from Quantum Chaotic Dynamics: A New Kind of Random-Matrix Universality

Dr HO Wen Wei (何文维), Stanford University, USA



Dr HO Wen Wei is currently a Stanford Institute of Theoretical Physics postdoctoral scholar at Stanford University where he researches on non-equilibrium quantum many-body phenomena and applications of emerging quantum technologies. Previously, he was a Moore postdoctoral fellow at Harvard University where he worked with Professors Mikhail Lukin and Eugene Demler. Beginning August 2022, he will be a President's Young (Assistant) Professor at the National University of Singapore.

Wen Wei got his PhD from the University of Geneva under Professor Dmitry Abanin in 2017, a MSc from the University of Waterloo/Perimeter Institute under Professor Guifre Vidal in 2015, and a BA from Princeton University in 2013, where he worked with Prof. Duncan Haldane.

Abstract:

Universality refers to the emergence of general properties of complex systems that are independent of precise microscopic details. Quantum thermalization is an example arising from out-of-equilibrium dynamics of strongly-interacting quantum many-body systems, where a local region over time becomes well described by a Gibbs ensemble governed only by a small handful of system parameters, e.g. temperature and chemical potential. The extensive amounts of entanglement generated between the local region and its complement (the "bath") is key to the emergence of such universality.

In this talk I will present a new kind of universal behavior arising from certain classes of quantum chaotic many-body dynamics, going beyond conventional thermalization. I will describe how a single many-body wavefunction encodes an ensemble of pure states supported on a small subsystem, each of which is correlated with a (projective) measurement outcome of the bath in a local basis. Then, I will show how the distribution of these quantum states approaches those of uniformly random ones, i.e. the ensemble forms what is known as a "quantum state design" in quantum information theory. Our work offers a new perspective to study quantum chaos, and establishes bridges between quantum many-body physics, quantum information and random matrix theory. Moreover, it provides a practical and hardware-efficient method to generating pseudo-random states, opening up new ways to design applications for quantum state tomography and bench-marking in near-term quantum devices.