

The 8th **PUBLIC** ExU COLLOQUIUM

October 25th (Sat.) **ONLINE**

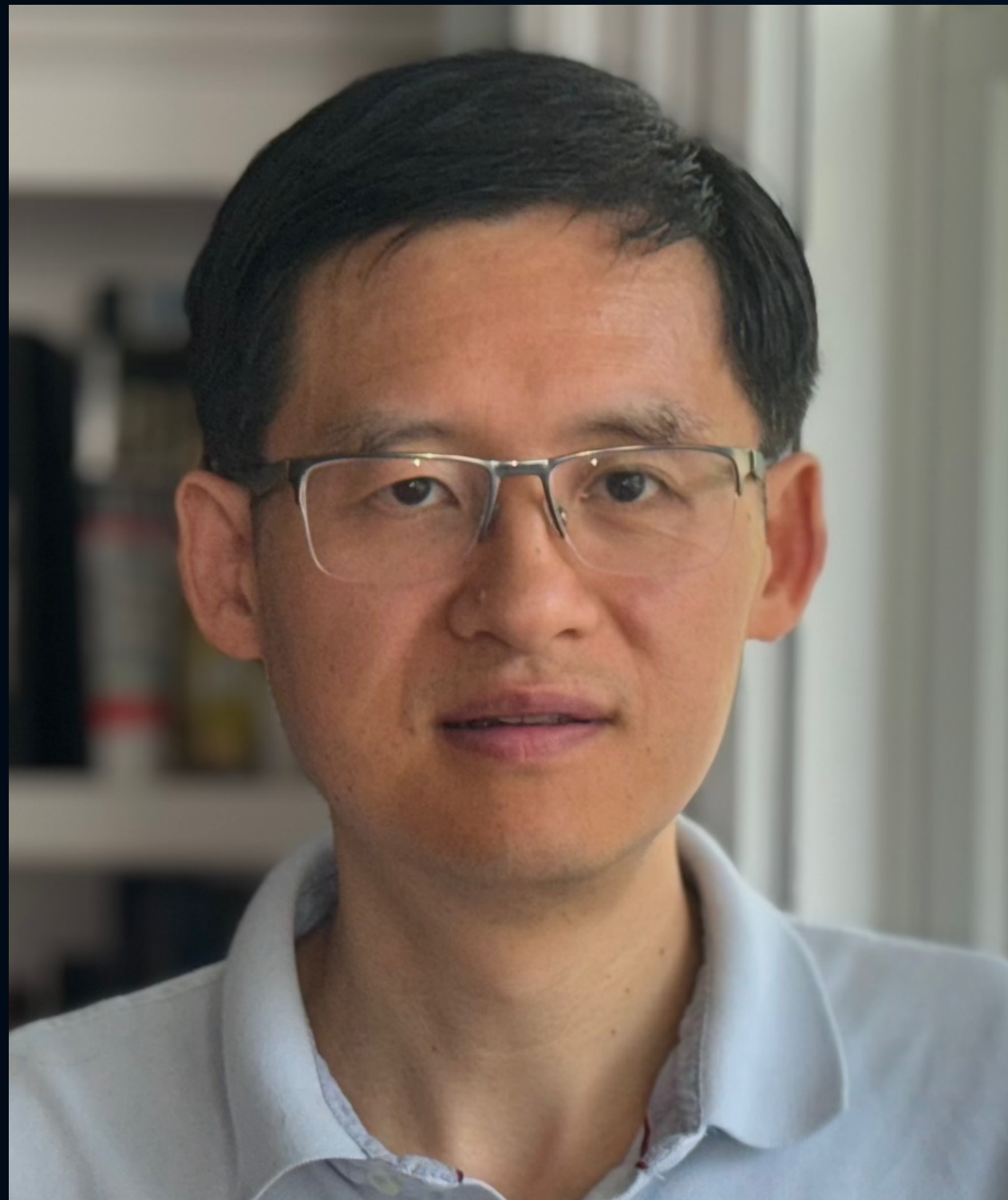
TALK 10:00 - 11:00 (JST)

October 24th (Fri.) 21:00 - 22:00 (EDT)

October 25th (Sat.) 1:00 - 2:00 (UTC)

ONLINE CHAT TIME
11:00 - 12:00 (JST)

Registration required (click [HERE](#))



Speaker

Prof. Hong Liu

Massachusetts Institute of Technology

Extreme Universe, JAPAN



MEXT -KAKENHI- Grant-in-Aid for Transformative Research Areas (A)
The Natural Laws of Extreme Universe

Entanglement, von Neumann algebras, and the emergence of spacetime

Abstract

Einstein's General Relativity says gravity is a manifestation of dynamic spacetime. There are, however, hints—particularly from string theory—that spacetime may be an emergent concept, analogous to fluids arising from large collections of molecules at macroscopic scales. Entanglement, which describes intrinsic quantum correlations without classical counterparts, was recognized early by Einstein, Podolsky, Rosen, and Schrödinger in the 1930s, but its significance in quantum many-body systems only gained prominence since the 2000s. Concurrently, von Neumann's work in the late 1920s and early 1930s on the mathematical foundations of quantum mechanics led to the development of operator algebras (now called von Neumann algebras), which have found wide applications in mathematics, but not so much in physics. These three seemingly disparate subjects—emergence of spacetime, entanglement, and von Neumann algebras—are now understood to be intricately connected, providing new languages and powerful tools for characterizing the emergence of spacetime.

Extreme Universe 2025