International Year of Quantum Science and Technology (IYQ)-2025, at TCG CREST (Kolkata, India)

Speaker:

Prof. Kenji Ohmori

Institute for Molecular Science (IMS),

National Institute of Natural Sciences, Japan

Date & Time :

5th February 2025 @ 3:00 PM (IST)

Venue:

Classroom-4

Prof. Kenji Ohmori is a Chair Professor at the Institute for Molecular Science, National institutes of Natural Sciences, Japan. He is one of the world leaders in neutral atom quantum computing and simulations. He is currently leading large-scale / long-term National projects supported by Government of Japan. He has received several awards including the National Medal with Purple Ribbon by His Majesty the Emperor of Japan for his achievements on quantum physics (2021).

Title: Ultrafast quantum simulation and quantum computing with ultracold atom arrays at quantum speed limit

Abstract: Many-body correlations drive a variety of important quantum phenomena and quantum machines including superconductivity and magnetism in condensed matter as well as quantum computers. Understanding and controlling quantum many-body correlations is thus one of the central goals of modern science and technology. My research group has recently pioneered a novel pathway towards this goal with nearby ultracold atoms excited with an ultrashort laser pulse to a Rydberg state far beyond the Rydberg blockade regime. We first applied our ultrafast coherent control with attosecond precision to a random ensemble of those Rydberg atoms in an optical dipole trap, and successfully observed and controlled their strongly correlated electron dynamics on a sub-nanosecond timescale. This new approach is now applied to arbitrary atom arrays assembled with optical lattices or optical tweezers that develop into a pathbreaking platform for quantum simulation and quantum computing on an ultrafast timescale.

In this ultrafast quantum computing, as schematically shown in the background image, we have recently succeeded in executing a controlled-Z gate, a conditional two-qubit gate essential for quantum computing, in only 6.5 nanoseconds at quantum speed limit, where the gate speed is solely determined by the interaction strength between two qubits. This is faster than any other two-qubit gates with cold-atom hardware by two orders of magnitude. It is also two orders of magnitude faster than the noise from the external environment and operating lasers, and thus can suppress those noise effects. Moreover, this two-qubit gate is faster than the fast two-qubit gate demonstrated recently by "Google AI Quantum" with superconducting qubits. This disruptive progress has been made possible not only by the ultrafast laser technologies, but also by our ultra-precise optical tweezers array and high-NA microscope technologies.

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