

中央大學物理學系

Department of Physics, National Central University



Colloquium

Quantum Sciences with Optical Lattices

Prof. Shau-Yu Lan (藍劭宇)

Department of Physics, NTU, Taiwan

Date: 2025/11/18 (Tue)

Venue: S4-625

Time: 14:00

Abstract :

Optical lattices, periodic light-shift potentials, trap neutral atoms in arrays of harmonic wells with tunable frequencies and dimensionality. Their site-resolved control and isolation make them natural stages for motional-state engineering and rapid state preparation. In this talk, I first show how motional squeezed states can be generated without the usual quantum-speed-limit buildup: a sudden change of each site's harmonic frequency projects the ground state directly into a squeezed state. This quench-based protocol enables rapid quantum amplification of a displacement operator, providing a high-bandwidth route to motion/force detection and offering speedups for motional gates in noisy environments. I then present a complementary fast route to many-body states: creating quantum gases with minimal time and resources. Using electromagnetically induced transparency cooling of individually pinned ^{85}Rb atoms in a 3D optical lattice followed by adiabatic expansion, we reach quantum degeneracy in ~ 10 ms. Adiabatic transfer to optical dipole traps verifies the transition via collapse in 3D for negative scattering length and the emergence of a stable, strongly correlated 1D gas.