

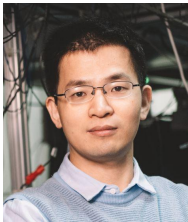
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## From Science-for-QC to QC-for-Science

*University of Science and Technology of China, China*

**Chao-Yang Lu**  
**Email: [cylu@ustc.edu.cn](mailto:cylu@ustc.edu.cn)**

I will go through our recent efforts in my group using photons and atoms to build increasingly large-scale quantum computers and, in turn, how these early quantum computers can already be used for studies of fundamental problems in mathematics, quantum physics, and condensed matter physics. We use the protocol of Gaussian boson sampling to demonstrate quantum computational advantage, with up to 255 detected photons [Zhong et al. Science 2020, PRL 2021, Deng et al. PRL 2023]. We develop an AI-enabled constant-time-overhead rearrangement protocol to prepare a 2024 defect-free atomic array [Lin et al. 2024]. Using a single atom trapped in an optical tweezer and cooled to the motional ground state in three dimensions, we faithfully realize the Einstein-Bohr recoiling-slit gedankenexperiment tunable at the quantum limit [Zhang et al. 2024]. Based on a bottom-up quantum engineering approach, we experimentally created the fractional quantum Hall state using strongly interacting photons [Wang et al. Science 2024]. We further use the quantum computing platform to rule out a real-value description of standard formalism of quantum theory [Chen et al. PRL 2022].



### **Short Bio:**

**Chao-Yang Lu** is a Chair Professor in Physics at the University of Science and Technology of China (USTC). He completed his BS and PhD degrees at the USTC and the University of Cambridge in 2011. He has been appointed as the Deputy Director of the Shanghai Center for Quantum Sciences and as the Executive Director of the Quantum Computing Division at the Hefei National Laboratory since 2022. His current research interest includes quantum computation, solid-state quantum photonics, quantum teleportation, superconducting circuits, and atomic arrays. He is the author of over 160 papers in major research journals which have attracted >35000 citations. His work has been selected as by Physics World as “Breakthrough of the Year” in 2015, by APS Physics as one of the top ten “Highlights of the Year” in 2021 and 2022,

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and by UNESCO as “World’ s top 10 digital innovation technologies” in 2021. He is an OSA/Optica/APS Fellow, and a recipient of the EPS Fresnel Prize, AAAS Newcomb Cleveland Prize, Nishina Asian Award, IUPAP-ICO Young Scientist Prize in Optics, OSA Adolph Lomb Medal, APS Rolf Landauer and Charles H. Bennett Award in Quantum Computing, CLEO James P. Gordon Memorial Speakership, and OCPA Achievement in Asia Award. He serves as the Divisional Associate Editor for Physical Review Letters, and recent appointed as the Chairman of World Association of Young Scientists.