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Programming Complexity: Large-Scale Photonics for Quantum Information and Machine Learning

After several decades of intensive theoretical and experimental efforts, the field of quantum information processing at a critical moment: special-purpose quantum information processors are at or past the "quantum complexity frontier" where classical computers can no longer predict their outputs: we can "program complexity", unable to predict the outcome. Meanwhile, new technologies to connect quantum processors by photons give rise to quantum networks with functions impossible on today's "classical-physics" internet.
However, to harness the power of quantum complexity in "noisy intermediate-scale" quantum computers and networks requires advanced methods in quantum control and noise mitigation – perhaps to the ultimate goal of fault tolerant computing. This talk discusses one approach in that direction: large-scale programmable photonic integrated circuits designed to control photons and atomic or atom-like quantum memories.
The second part of the talk considers another "complexity frontier": that encountered in machine learning and signal processing when trying to process exponentially growing quantities of data. These problems present new opportunities at the intersection with quantum information technologies – specifically, we will consider new directions for processing classical and quantum information in deep learning neural networks architectures.