Classical Meets Quantum: No Room For Squares

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Abstract
At the core of the lightwave communications infrastructure underpinning the internet today sit photons—ephemeral particles carrying classical information down vast swaths of optical fiber across the globe. And as the only realistic candidates for "flying qubits," photons are critical for emerging quantum networks as well, which promise to revolutionize security, sensing, and computing. Light's centrality to both classical and quantum communications hints at untapped potential at their intersection, where mature technologies from lightwave communications can be translated to more nascent quantum applications.

In this talk, I will describe my research straddling classical and quantum photonics, with a particular focus on frequency-bin encoding, a paradigm marked not only by ease of multiplexing and stability in optical fiber, but also by practical challenges for state manipulation and control. As a solution for universal and scalable frequency-bin quantum information, I will introduce the quantum frequency processor (QFP), a classically inspired scheme based on Fourier-transform pulse shapers and electro-optic phase modulators. Summarizing recent successes with the QFP, I will conclude with a vision for future research encompassing frequency bins, quantum circuit design, and Bayesian inference. Throughout, it is my hope to show that there is "no room for squares" in quantum photonics: quantum engineers must be open to and fluent with classical lightwave communications—the future of quantum networking depends on it.

Bio
Joseph M. Lukens received the B.S. degree in electrical engineering and physics in 2011 from the University of Alabama, Tuscaloosa, and the Ph.D. degree in electrical engineering from Purdue University, West Lafayette, Indiana, in 2015. Employed as a Wigner Fellow and Research Scientist in Quantum Information Science at Oak Ridge National Laboratory (ORNL) from 2015–2022, he now serves as Senior Director of Quantum Networking and Research Professor at Arizona State University, maintaining a joint faculty appointment at ORNL. His research interests encompass a variety of topics in photonic quantum information processing, optical networking, and Bayesian inference.

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