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Verifying the Unverifiable: Certifying Quantum Complexity in Linear Optical Experiments

Photons propagating through integrated linear optical circuits have emerged as a promising candidate for quantum technologies due to their outstanding low-noise properties and prospects for scalability. I will give a brief overview of photonic quantum computing then motivate a class on non-universal quantum simulator, a boson sampler, which promises to achieve quantum supremacy in the much nearer term. The complexity of this type algorithm means its solution is formally unverifiable and the task of establishing correct operation becomes one of gathering sufficiently convincing circumstantial evidence. I will present scalable methods to experimentally establish correct operation for this class of sampling algorithm, which we implement with two different types of optical circuits for 3, 4, and 5 photons, on Hilbert spaces of up to 50,000 dimensions. Finally, I will present new work on reconfigurable linear optical circuits, whose versatility can be applied to a wide variety of quantum experiments. These results have wider applications in the verification of large scale quantum systems and photonic quantum computing beyond boson sampling.