Racing classical computers with quantum boson-sampling machines

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Boson sampling is considered as a strong candidate to demonstrate the “quantum supremacy” over classical computers. However, previous proof-of-principle experiments suffered from small photon number and low sampling rates owing to the inefficiencies of the single-photon sources and multi-port optical interferometers [1]. In this talk, I will report two routes towards building Boson Sampling machines with many photons.

In the first path, we developed SPDC two-photon source with simultaneously a collection efficiency of ~70% and an indistinguishability of ~91% between independent photons. With this, we demonstrate genuine entanglement of ten photons [2]. Such a platform will provide enabling technologies for teleportation of multiple properties of photons and efficient scattershot Boson Sampling.

In the second path, using a QD-micropillar, we produced single photons with high purity (>99%), near-unity indistinguishability for >1000 photons [3], and high extraction efficiency [4]—all combined in a single device compatibly and simultaneously. We build 3-, 4-, and 5-bosonsampling machines which runs >24,000 times faster than all the previous experiments, and for the first time reaches a complexity about 100 times faster than the first electronic computer (ENIAC) and transistorized computer (TRADIC) in the human history [5,6]. Our architecture is feasible to be scaled up, and might provide experimental evidence against the Extended Church-Turing Thesis.

References: