Quantum light source engineering towards “quantum supremacy”

Chao-Yang Lu

University of Science and Technology of China, Hefei, P.R. China

Quantum computers can in principle solve certain problems faster than classical computers. Despite substantial progress in the past decades, building quantum machines that can actually outperform classical computers for some specific tasks—a milestone termed as “quantum supremacy”—remained challenging. Boson sampling has been considered as a strong candidate to demonstrate the “quantum supremacy”. The challenge for realizing a large-scale boson sampling mainly lies in the lack of perfect quantum light sources. To this end, using single semiconductor quantum dot deterministically coupled to elliptical micropillars, we produced polarized single photons with near-unity purity, indistinguishability for >1000 photons, and high extraction efficiency—all combined in a single device compatibly and simultaneously [PRL 116, 020401 (2016)]. We built boson sampling machines with increasingly large number of photons to race against classical computers [Nature Photonics 11, 365 (2017)]. We also developed SPDC entangled two-photon source with simultaneously a collection efficiency of 97% and an indistinguishability of 96% between independent photons [PRL 121, 250505 (2018)]. The probabilistic nature of SPDC could be overcome using cascaded transition of a single quantum dot embedded in a broadband microcavity [PRL 122, 113602 (2019)].