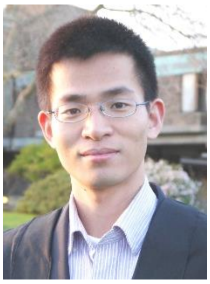
量子信息科技学术研讨会 (2018.9.17-21)

报告



面向量子霸权的多光子波色取样

Multi-photon Boson Sampling Towards Quantum Supremacy

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讲者介绍 Biography

陆朝阳，1982 年出生浙江，2004 年 7 月中国科学技术大学物理系毕业获得学士学位，2011 年 3 月获得英国剑桥大学物理学博士学位，同时入选剑桥大学丘吉尔学院 Fellow。2011 年 6 月回国被聘为中国科学技术大学教授。长期致力于量子信息科学研究，在包括《自然》和《科学》5 篇、《自然》子刊 9 篇、《物理评论快报》26 篇等国际顶级学术期刊发表论文 60 余篇。成果入选 2015 年英国物理学会评选的国际物理学年度突破榜首，两次入选美国光学学会评选的国际光学重要进展，四次入选两院院士评选的年度中国科技十大进展新闻。2011 年入选国家青年千人计划，2012 年入选国家优秀青年科学基金，2014 年获得香港求是杰出青年学者奖，2015 年获得国家杰出青年科学基金、国家自然科学一等奖，2016 年被《自然》评为“中国科学之星”，并入选美国光学学会会士，2017 年获得中国青年五四奖章、欧洲物理学会“菲涅尔奖”。现兼任国际量子通信、测量与计算学会执委会委员、科学通报副主编、英国物理学会 Quantum Science and Technology 期刊编委等。

报告摘要 Abstract

Boson sampling is considered as a strong candidate to demonstrate the “quantum advantage / 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. 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 [1]. Very recently, we managed to observe 12-photon entanglement using a novel SPDC source. Such a platform will provide enabling technologies for teleportation of multiple properties of photons [2] 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) [5,6]. We are currently increasing the rate by optimizing the single-photon system efficiency to near unity, background-free resonance fluorescence, and using improved schemes such as boson sampling with photon loss [7], with the hope of achieving 20-photon boson sampling in the near term.

[1] X.-L. Wang et al. Experimental ten-photon entanglement, Phys. Rev. Lett. 117, 210502 (2016).

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[3] H. Wang et al. Near transform-limited single photons from an efficient solid-state quantum emitter, Phys. Rev. Lett. 116, 213601 (2016).

[4] X. Ding et al. On-demand single photons with high extraction efficiency and near-unity indistinguishability from a resonantly driven quantum dot in a micropillar, Phys. Rev. Lett. 116, 020401 (2016).

[5] H. Wang et al. Multi-photon boson-sampling machines beating early classical computers, Nature Photonics 11, 361 (2017)

[6] Y. He, et al. Time-bin-encoded boson sampling with a single-photon device, Phys. Rev. Lett. 118, 190501 (2017)

[7] H. Wang et al. Toward scalable boson sampling with photon loss, Phys. Rev. Lett. 120.230502 (2018)