High-Dimensional Quantum Key Distribution using Orbital Angular Momentum of Single Photons from a Room-Temperature Colloidal Quantum Dot

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High-dimensional quantum key distribution (HDQKD) is a promising avenue to address the inherent limitations of basic QKD protocols. However, experimental realizations of HDQKD to date have relied on indeterministic photon sources that limit the achievable key rate. In this work [1], we demonstrate a full emulation of a HDQKD system using a single colloidal giant quantum dot (gQD) as a deterministic, compact and room-temperature single-photon source (SPS) [2, 3]. We demonstrate a practical protocol by encoding information in a high-dimensional space ($d = 3$) of the orbital angular momentum of the photons. Our experimental configuration incorporates two spatial light modulators for encoding and decoding the spatial information carried by individual photons. Our demonstration establishes the feasibility of utilizing high radiative quantum yield gQDs as practical SPSs for HDQKD. We also experimentally demonstrate surpassing the traditional $d = 2$ QKD capacity with comparable error rates, indicating a significant improvement in performance while maintaining reliability.

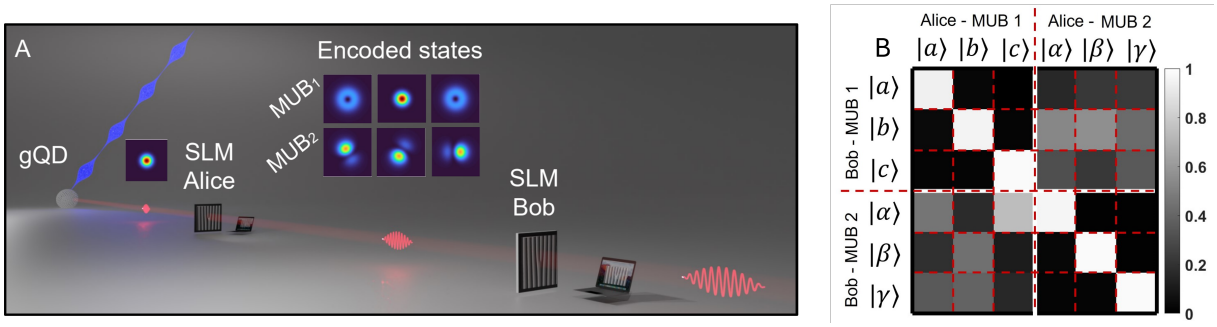

Figure 1: (A) A visualization of the experimental process: a pulsed laser excites a gQD, generating single photons that are encoded with spatial information by Alice's SLM and projected onto corresponding modes by Bob's SLM. (B) Projection measurements: normalized single-photon detection counts for different basis selections by Alice and Bob.

References

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