Optical Quantum Machines: Harnessing Semiconductor Sources and Integrated Photonic Circuits

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Integrated quantum machines with reconfigurable dedicated or universal hardware can now provide quantum resources or accomplish quantum tasks in a compact and stable manner. Solid-state single photon or photon pair sources offer practicality, flexibility and unprecedented rates. I shall present photonic demonstrations of practical quantum tasks that combine either a silicon microresonators parametric broadband source and fibered manipulation of frequency encoding in a single spatial mode [1, 2] or an on-demand quantum dot in cavity source and integrated optical elements, exploiting dual rail encoding in an integrated photonic chip [3, 4].

Scalability and reliability of the approaches will be discussed and notably an efficient and scalable integrated photonic chip characterization method will be introduced. Our clear-box approach of characterization – that leverages on explicit physical dependence – and mitigation method provide an average 99.77% amplitude fidelity on 100 implemented Haar-random unitary matrices, the highest value achieved in the literature, measured on one of the biggest available circuits [5]. This enhancement of photonic integrated circuit performance or the dense coding, hyperentanglement, multiplexing and parallelization, and large distance traveling without stabilization or drift compensation allowed by frequency encoding broadens applications in both classical and quantum photonic technologies.

References

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