Achieving the ultimate end-to-end rates of lossy quantum communication networks

M. S. Winnel[a], J. J. Guanzon[a], N. Hosseinidehaj[a], and T. C. Ralph[a]

[a] *Centre for Quantum Computation and Communication Technology, School of Mathematics and Physics, University of Queensland, St Lucia, Queensland 4072, Australia*

Quantum repeaters are strictly necessary for long-distance quantum communication, and the field of research is rapidly evolving. Quantum repeaters allow quantum computers, quantum sensors, and other quantum devices to communicate with each other over long distances, forming a quantum version of the conventional internet. While the current internet is composed of computers and devices connected by classical communication channels, the quantum internet will be composed of nodes connected by quantum channels. In our work [1], we propose a practical protocol which achieves the fastest quantum communication rates allowed by quantum physics; a necessary requirement for realising the full potential of the quantum internet. Thus, our work is significant and will be interesting to a broad range of physicists.

Our protocol works by detecting loss which is the major obstacle for doing quantum communications over global distances. Our protocol purifies entanglement completely, in contrast to previous repeater techniques which fail. We show that complicated error correction is not necessary to achieve the highest rates, rather, error detection is sufficient while also being more experimentally practical. We reduce the complexity of our ultimate scheme and show it can be implemented using linear optics while still achieving excellent rates. Importantly, it is naturally robust against inefficient detectors and noisy resource states.

[1] M. S. Winnel, J. J. Guanzon, N. Hosseinidehaj, and T. C. Ralph, "Achieving the ultimate end-to-end rates of lossy quantum communication networks," (2022), arXiv:2203.13924.