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Beating the Classical Limits of Information Transmission using a Quantum Decoder AKIB KARIM, ZIXIN HUANG, ROB CHAPMAN, University of Sydney, RMIT University, MARCO TOMAMICHEL, STEVE FLAMMIA, University of Sydney, ALBERTO PERUZZO, University of Sydney, RMIT University — Reliable transmission of information over a noisy channel is a fundamental challenge in communication theory. The emergence of quantum technologies has created a new class of strategies that allow for message recovery greater than purely classical methods. Despite this, for minimal uses of the channel, finding such schemes remains a challenge. We investigate the amplitude damping channel which describes physical systems that suffer energy loss such as in cavity quantum electrodynamics or spin chain excitations. We derive and experimentally demonstrate the fundamental limit for message recovery possible with only classical methods. We then propose a quantum decoder and experimentally demonstrate message recovery past this classical limit. We use polarisation-encoded photonic qubits. The post-amplitude damping states are generated by an unbalanced Mach-Zehnder interferometer and entanglement is accomplished with a linear optical probabilistic controlled z gate. Our quantum decoder uses a single entangling gate at the receiver where other similar schemes rely on both the sender and the receiver having quantum devices. Our results present an advance in discovering the quantum capabilities of finite resource communications, with specific regard to the amplitude damping channel.

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