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Quantum Capacity of Pauli Channels

The quantum capacity captures the value of a quantum channel for transmitting quantum information, establishing fundamental limits on quantum communication. In spite of its central role in quantum information, the quantum capacity of most channels is unknown. In our recent work, we report significant increases in the capacity thresholds of the depolarizing channel. This is the first improvement in 18 years, giving a bigger increase beyond the hashing bound than all previous improvements combined. Our starting point is the representation theoretic framework recently proposed by Bhalerao and Leditzky (2025) to compute coherent information for special permutation invariant states. We generalize their framework to the full symmetric subspace, which allow us to optimize coherent information over rank two states in that space. A representation theoretic calculation shows that exponentially many Kraus operators of the channel annihilate the symmetric space, corresponding to a massive decrease in environment entropy for states on the symmetric space compared to the maximally mixed state. This explains the enhanced coherent information as a manifestation of degeneracy for the resulting codes.