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The platypus of the quantum channel zoo and their generic nonadditivity

Understanding quantum channels and the strange behavior of their capacities is a key objective of quantum information theory. One approach is to develop the menagerie of the diverse and complex phenomena displayed by quantum channels. To this end, we construct several families of quantum channels with exotic quantum information-theoretic features. The simplest example of the first family is obtained by gluing together a maximally useful and a completely useless qubit channel, and the resulting channel is unlike either of the constituent channels, and unlike any other known class of channels. In particular, it has additive quantum, private and classical capacity expressions, but the private capacity is significantly larger than the quantum capacity, and the channel has superadditive quantum capacity when used jointly with many other generically chosen channels. While part of the above results rely on a convincing conjecture, we construct a second related family of channels and prove similar results unconditionally.

Joint work with Felix Leditzky, Vikesh Siddhu, Graeme Smith, John Smolin

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