Quantum Physics

Sequential, successive, and simultaneous decoders for entanglement-assisted classical communication

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Bennett et al. showed that allowing shared entanglement between a sender and receiver before communication begins dramatically simplifies the theory of quantum channels, and these results suggest that it would be worthwhile to study other scenarios for entanglement-assisted classical communication. In this vein, the present paper makes several contributions to the theory of entanglement-assisted classical communication. First, we rephrase the Giovannetti-Lloyd-Maccone sequential decoding argument as a more general "packing lemma" and show that it gives an alternate way of achieving the entanglement-assisted classical capacity. Next, we show that a similar sequential decoder can achieve the Hsieh-Devetak-Winter region for entanglement-assisted classical communication over a multiple access channel. Third, we prove the existence of a quantum simultaneous decoder for entanglement-assisted classical communication over a multiple access channel with two senders. This result implies a solution of the quantum simultaneous decoding conjecture for unassisted classical communication over quantum multiple access channels with two senders, but the three-sender case still remains open (Sen recently and independently solved this unassisted two-sender case with a different technique). We then leverage this result to recover the known regions for unassisted and assisted quantum communication over a quantum multiple access channel, though our proof exploits a coherent quantum simultaneous decoder. Finally, we determine an achievable rate region for communication over an entanglement-assisted bosonic multiple access channel and compare it with the Yen-Shapiro outer bound for unassisted communication over the same channel.

Comments:	33 pages, 2 figures; v2 contains a proof of the quantum simultaneous decoding conjecture for two-sender quantum multiple access channels; v3 shows how to recover the known unassisted and assisted quantum communication regions with a coherent quantum simultaneous decoder
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