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# Quantum information processing as classical processing of complementary information

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In a wide variety of settings, quantum information can be treated as a kind of combination of two types of classical information, information about complementary observables. Here I shall explain precisely what this means, why it is intimately related to the uncertainty principle, and how we can use this intuition to blindly construct all manner of quantum communication protocols from more rudimentary classical protocols.

In particular I shall focus on the problem of noisy channel communication and show that using this method one can directly construct capacity-achieving quantum codes from capacity-achieving classical-quantum codes. Together with some fortunate properties of classical polar codes, this directly leads to a construction of quantum polar codes. These enjoy the same properties as their classical counterparts for certain channels, namely efficient encoding and decoding at rates up to the (symmetric) capacity for arbitrary noise rates.

Time permitting, I will also briefly describe how this "complementarity" approach enables us to turn privacy amplification against quantum adversaries into information reconciliation. This has a number of interesting applications itself. The first is a universal noisy channel coding scheme for one-shot communication under a max-entropy constraint, which requires very little randomness as it is based on Trevisan extractors. The second is the possibility of constructing noisy channel codes and other information processing protocols by removing (two types of) classical information from the environment, similar in spirit to the decoupling approach.

*This is joint work with Jean-Christian Boileau, Frédéric Dupuis, and Renato Renner, partially appearing in* `arXiv:1109.3195`, `arXiv:1003.0703`, `arXiv:1003.1150`, `arXiv:0803.3096`.

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