Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Polar codes for achieving the classical capacity of a quantum channel SAIKAT GUHA, Raytheon BBN Technologies, MARK WILDE, McGill University — We construct the first near-explicit, linear, polar codes that achieve the capacity for classical communication over quantum channels. The codes exploit the channel polarization phenomenon observed by Arikan for classical channels. Channel polarization is an effect in which one can synthesize a set of channels, by "channel combining" and "channel splitting," in which a fraction of the synthesized channels is perfect for data transmission while the other fraction is completely useless for data transmission, with the good fraction equal to the capacity of the channel. Our main technical contributions are threefold. First, we demonstrate that the channel polarization effect occurs for channels with classical inputs and quantum outputs. We then construct linear polar codes based on this effect, and the encoding complexity is O(N log N), where N is the blocklength of the code. We also demonstrate that a quantum successive cancellation decoder works well, i.e., the word error rate decays exponentially with the blocklength of the code. For a quantum channel with binary pure-state outputs, such as a binary-phase-shift-keyed coherent-state optical communication alphabet, the symmetric Holevo information rate is in fact the ultimate channel capacity, which is achieved by our polar code.

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Date submitted: 09 Nov 2011 Electronic form version 1.4