Near-field Reliability: the Problem

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Abstract

In this note, the authors propose to study the reliability function of a quantum mechanical communication system that operates only in the near-field zone.

Consider quantum communication within the near-field zone. This setting can model quantum communication between nearby neurons (please see the case of ephaptic coupling considered in the doctoral dissertation of the author). It can possibly also be extended to minutely understand the exchange of information about a qubit via an electric field during a continuous quantum measurement (as in the work of Steck and Jacobs).

Specifically, Part II on the semi-classical theory of near field electrodynamics from Ole Keller's text on "The Quantum Theory of Near-Field Electrodynamics" can be used to rederive Equation (8) from Jane Liu's work on the reliability of quantum-mechanical communication systems. By doing so, one will be able to finally derive the reliability function of near-field quantum communication systems. This can tell us the decoding delays that must necessarily be involved in communication in these settings. For settings such as neurons, where there may not necessarily be full decoding operations, this can tell us how reduction in decoding time affects the bit reliability, though finite block length and uncoded transmission effects might also become important.

The above theoretical investigation can be supplemented by numerical simulation experiments. Issues of entanglement can further be explored in this context.