Local Information and Nonorthogonal States

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Measurements of quantum systems extract only classical information. This dichotomy between physically real and physically discoverable information underlies many of the conceptual and metaphysical challenges of quantum theory. In particular, nonorthogonal quantum states can never be reliably distinguished; this simple fact has wide-ranging implications, such as the no-cloning theorem and the security of quantum cryptography.

Another quantum mechanical novelty is nonlocality - the existence of physical systems whose correlated behaviour violates local realism. Nonlocality arises when quantum systems' parts are measured and studied separately, even when the results of such measurements are public. I study the information which can be extracted from nonorthogonal systems under exactly this constraint. By focussing upon simple qubit-based systems, some primitive properties emerge which demonstrate both the drawbacks and the advantages of nonorthogonally-encoded information. Although they can never be perfectly distinguished, nonorthogonal systems can nevertheless *reliably* store and yield classical information, and this is particularly apparent in a local framework. For example, all locally indistinguishable sets quantum states can be rendered perfectly distinguishable by the addition of one system in a complementary set of purely nonorthogonal states. In fact, arbitrarily large sets of arbitrarily multipartite nonorthogonal states can always be found such that just one copy always suffices to reduce the set of possible states of a system to just two. I discuss a number of protocols whereby such nonorthogonal states can be used to locally encode and process classical information in a reliable fashion.