Perfect state transfer within networks of arbitrary topology

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The task of constructing a quantum computer has many technical challenges associated with it. One such example is transferring the state of a quantum system between different components of a quantum computer [1]. A common approach to this problem is the use of a quantum wire, i.e. a chain or network of coupled quantum systems where the interactions are such that the quantum state is transferred through the wire. Many different realizations of such perfect state transfer (PST), using quantum wires, have been proposed [2-4]. The approach that is often taken to the problem of PST is to construct a Hamiltonian and show that this allows the state to be perfectly transferred. An alternative approach has been proposed that enables a broad class of Hamiltonians to be constructed [5]. This approach does not make any assumptions about the coupling or the topology of the network. Instead, a class of Hamiltonians that lead to a particular permutation are derived. This work was developed for the task of transferring a state between two points in a network. We will show how one can use the formalism outlined in [5] to control quantum information in a more general manner. For example, we may wish to transfer a state to several different nodes within a network, at different times. This would enable us to generalize the problem of PST to networks with a nontrivial logical bus topology. The formalism can also be used to find Hamiltonians that enable PST when we have multiple interacting excitations.

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