## Superposition of topologies: indefinitely ordered composition of quantum channels

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Recent advances in the Quantum Computation and information Processing have put forward the idea of non causal order or indefinite causal order of processes. In similar manner to entanglement of state vectors, now gates or quantum channels occur in a non fixed order (A first then B). Instead they can be set in a superposition of orders (A before B and B before A). Such concrete situation is implemented via a quantum switch; a prototype procedure using two qubits, where the control qubit determines the order in which two operations A and B, act on the "target qubit". Within this framework a superposition of topologies is implemented as follows: employing of topological states exhibited by a 1D lattice model (the target system); here the (Su-Schrieffer-Heeger) SSH model, via its dependence on two real parameters $a$ and $b$. The criterion of trivial topology ($a < b$; broken handle tea mug, i.e. ball) or non-trivial topology ($a > b$; unbroken handle tea mug; torus), is mathematically expressed by a witness operator (concretized by the value of a contour complex integral evaluating the trace of an operator determining model's Hamiltonian). By that property two random unitary quantum channels are constructed with Kraus generators provided by models unitary evolution operator, both for the trivial ($a < b$) and the non-trivial ($a > b$) topologies. These two channels are combined by a novel quantum switch. Depending on the control-system resulting quantum state the value of the witness operator will manifest the underlying topology of the system i.e. the SSH lattice model. Sharp topological states c.f. trivial (ball) or non-trivial (torus), or superposition of both those states are obtained as outcomes of quantum measurements performed on model's state. The obtained results are a novel manifestation of the effect of non-casual order of various state maps for quantum systems. The same method addressing the topological question equivalently addresses the problem of ordering two real numbers $a, b$; $a > b$ or $b > a$. Both the topological and the comparison problems are shown to be solved by constructing a comparator quantum algorithm that employs quantum switch of channels, superposition of topological states and quantum measurements.