

Speaker: Steven Tomsovic, Washington State University
Title: Is Quantum Chaos Required for Quantum Control?
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In classical mechanics chaos is associated with unpredictability and thermalization, hence, the nemesis of control. However, the field of controlling classical chaos shows that under some circumstances systems can be steered very efficiently using small perturbations due to the presence of exponential instability and ergodicity. A natural question to ask would be, 'is there an analogous quantum mechanical control process. A rather straightforward starting point is to construct a quantum version of Shinbrot, Ott, Grebogi, and Yorke's classical targeting, which is the very weakly perturbative process of using the system's extreme sensitivity to initial conditions in order to arrive at a predetermined target state. We performed this construction in a couple of ways and applied it to both the quantum kicked rotor and the Bose-Hubbard model in chaotic dynamical regimes. While quite interesting, these techniques suppress quantum interference effects, are currently limited to localized states in single particle and bosonic many-body systems, and end up effectively simulating classically chaotic trajectories.

An alternative, still inspired by controlling chaos, is to take advantage of the universal features of quantum chaos, namely: 1) the exponential decay laws of Peres' fidelity, which measure the sensitivity of quantum systems to perturbations; and 2) the property of random matrix theory that states that every spectrum and every eigenbasis are members of the ensemble. These can be viewed as the quantum substitutions for classical instability and ergodicity. We argue that these features are essential for full state controllability and may be the closest translation of classical chaos control to the quantum realm.