# Abstract

Recent studies have established that properly designed periodic driving protocols can generate synthetic gauge structures which may be used to simulate interesting static Hamiltonians. Theoretically, this class of systems is analyzed by employing the Floquet theory. One important outcome of this analysis is the Floquet Hamiltonian, which is the effective time-independent Hamiltonian of the time-periodic Hamiltonian. This thesis has studied integrable, as well as nonintegrable, periodically driven quantum systems under the Floquet theory.

After presenting the motivation behind studying these systems in the introductory chapter, we present a discussion about the Floquet theory and its application in the derivation of the effective Hamiltonian of the system. In general, the effective Hamiltonians can not be calculated exactly by any analytical means. This thesis also discusses two perturbation theories which can be used at the high frequency limit to derive the effective Hamiltonians. We then study a classically nonintegrable system that displays chaos, but its quantum spectrum does not follow the random matrix based prediction of the quantum chaos theory. The system which we consider here is the double kicked tops. This system's spectrum shows the fractal property, which has some connection with the celebrated Hofstadter butterfly via certain number theoretical property. Our analysis reveals that the spectrum of the effective Hamiltonian of this system preserves a similar fractal nature. A detailed analysis of this spectrum reveals that this is a multifractal that needs multiple scales to describe its property.

Next, we consider an integrable system of bosons on the one-dimensional lattice, which interacts strongly in a repulsive manner. These bosons are called hard core bosons, and the repulsive interaction does not allow two bosons at the same site. The hard core bosons can be mapped into spinless fermions by Jordan-Wigner

transformation. Thus the hard core bosons can simulate many of the properties of the spinless fermions discussed in standard solid state texts. Our study of this system reveals that, if a single kicked pulse drives the systems within a time period, then it shows dynamical localization. However, if we introduce another kick after the first kicks but in the opposite direction, then the second kick can tune the effect of the first kick and partially or even completely modify the dynamics of the system.

The last system which we study is another nonintegrable system, which is a couple kicked top. Unlike the previously studied nonintegrable systems, the effective Hamiltonian of this system remains nonintegrable and shows chaos in some parameter regimes. Interestingly the spectrum of this system follows one of the nonstandard symmetries, and therefore its spectrum behaves differently than the standard Wigner-Dyson classification. Rather, its spectrum falls into one of the recently proposed tenfold classifications. Finally, we conclude the thesis and discuss the immediate future direction of this thesis.