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Squeezing, Chaos and Thermalization in Periodically Driven Quantum Systems: The Case of Bosonic Preheating

The phenomena of Squeezing and chaos have recently been studied in the context of inflation. We apply this formalism in the post-inflationary preheating phase. During this phase, inflaton field undergoes quasi-periodic oscillation, which acts as a driving force for the resonant growth of quantum fluctuation or particle production. Furthermore, the quantum state of the fluctuations is known to have evolved into a squeezed state. In this submission, we explore the underlying connection between the resonant growth, squeezing, and chaos by computing the Out of Time Order Correlator (OTOC) of phase space variables and establishing a relation among the Lyapunov, Floquet exponents, and squeezing parameters. For our study, we consider observationally favored α-attractor E-model of inflaton which is coupled with the bosonic field. After the production, the system of produced bosonic fluctuations/particles from the inflaton is supposed to thermalize, and that is believed to have an intriguing connection to the nature of chaos of the system under perturbation. We conjecture a relation between the thermalization temperature ($\bar{T}_{\rm SS}$) of the system and quantum squeezing, which is further shown to be consistent with the well-known Rayleigh-Jeans formula for the temperature symbolized as $\bar{T}_{\rm RJ}$, and that is $\bar{T}_{\rm SS} \simeq \bar{T}_{\rm RJ}$. Finally, we show that the system temperature is in accord with the well-known lower bound on the temperature of a chaotic system proposed by Maldacena-Shenker-Stanford (MSS).

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