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Peer Review

Review of: "Observation of Prethermalization in Weakly Nonintegrable Unitary Maps"

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In this paper, the authors study prethermalization near the integrable limit in two models using Lyapunov exponents. In the LRN case, they demonstrate that the system converges to a thermalized state regardless of the initial conditions by showing that the time-averaged Lyapunov exponents converge to the same value in all cases. On the other hand, in the SRN case, different prethermalized states emerge depending on the initial conditions, as evidenced by the time-averaged Lyapunov exponents converging to different values on an intermediate time scale. The numerical results are compelling and well-interpreted. However, I recommend the authors address the following issues before publication.

Major Comments:

1. **Prethermalization Time Scale**:

   Are there any analytical or numerical relations between the prethermalization time scale and the parameters $\theta\theta$ and g of the theory? In other words, how does the time scale of the prethermalized states depend on $\theta\theta$ and g?

2. **Thermalization Time Scale**:

   Similar to the first question, what is the thermalization time scale in terms of $\theta\theta$ and g? Understanding this relationship would provide deeper insights into the dynamics of the system.

3. **Intermediate Case Between LRN and SRN**:

   The manuscript investigates two limiting cases (LRN and SRN), which exhibit distinct intermediate-time behaviors. If a more general case (somewhere between LRN and SRN) is considered, what happens? Does the prethermalized state change abruptly with the parameters, similar to a phase transition, or is there a smooth crossover between the two regimes?

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4. **Power-Law Behavior in Fig. 10**:

   In Fig. 10, although the variance σσ does not follow a t−1/2t−1/2 behavior, it appears to follow a power-law decay with a smaller universal exponent. Does this suggest some form of universality in the prethermalized state for this model? A discussion on this point would be valuable.

5. **Smallest Lyapunov Exponent and Spectrum Consideration**:

   The paper focuses only on the largest Lyapunov exponent. What happens if the smallest Lyapunov exponent is considered? In the LRN case, does the smallest Lyapunov exponent also converge to the same value regardless of the initial state? How does it behave in the prethermalized state? Furthermore, does the difference between the largest and smallest Lyapunov exponents exhibit distinct behavior depending on the model parameters? Addressing these points could provide a more comprehensive understanding of the system's chaotic properties.

Declarations

Potential competing interests: No potential competing interests to declare.