RESPONSE TO THE COMMENTS MADE BY THE REVIEWER – 2

Comment. At this stage, the manuscript is not in the position to be accepted. There is not enough discussion on the background, AAH model and the connection to the quantities studied. All the results are mostly numerical observations without any strong physical arguments such as phenomenological pictures to back them. Some observations are completely left without explanation. For example, 1. in Sec. III J, why the re-entrant transitions and what are the expectations for this transition? 2. Another point is why tuning phi to such values, what is so special about choosing phi=pi/2. 3. The connection between average IPR and NPR with the current seems to be mere accidental unless backed with proper physical picture. Considering all of these factors I do not recommend this manuscript for publication unless major revision is done to include physical arguments, enough discussions to back the numerical observations.

Reply. We are extremely sorry about the earlier lack of clarity and sincerely thank the referee for pointing this out. In response, we have carefully revised the manuscript to improve clarity and organization. The major changes and clarifications are as follows:

- The background discussion, literature survey, and the motivation behind our proposed model have been elaborated in Subsection K. In addition, the motivation is now presented more clearly in the Introduction section.

- The content of Section III, Subsection H has been comprehensively rewritten for better organization, and Subsection J has been revised with a new paragraph to improve readability and to present the physical insights more transparently.

- The justification for choosing specific values of ϕ_2 (such as 0, π, and $\pi/2$) is now explicitly provided in Subsection K

  (*In this model, we introduce two Aubry–André–Harper (AAH) phases, ϕ_1 and ϕ_2, and examine three representative cases of ϕ_2 while fixing $\phi_1 = 0$, namely $\phi_2 = 0, \pi$, and $\pi/2$, corresponding to distinct physical configurations. For $\phi_2 = 0$, both sites in a unit cell share identical potentials $(1 + \lambda_2 \cos 2\pi ib)$, yielding a non-staggered profile. When $\phi_2 = \pi$, the potentials become $(1 + \lambda_2 \cos 2\pi ib)$ and $(1 - \lambda_2 \cos 2\pi ib)$, forming a staggered pattern. For $\phi_2 = \pi/2$, the sites acquire $(1 + \lambda_2 \cos 2\pi ib)$ and $(1 - \lambda_2 \sin 2\pi ib)$, producing a mixed cosine–sine landscape. These three phase choices enable a systematic exploration of how non-staggered, staggered, and hybrid modulations govern localization, delocalization, and transport characteristics.*).

- The connection between the inverse participation ratio (IPR), normalized participation ratio (NPR), and the charge current has been clearly established. In particular, we present the current–NPR relation using both the state current–NPR framework and the NPR–eigenstate framework in Appendix B. We have moved this detailed discussion to the appendix to avoid further lengthening the main text.