Contribution ID: **92** Type: **Poster**

Shapiro steps in driven atomic Josephson junctions

Wednesday, 13 September 2023 22:40 (20 minutes)

We study driven atomic Josephson junctions realized by coupling two two-dimensional atomic clouds with a tunneling barrier. By moving the barrier at a constant velocity, dc and ac Josephson regimes are characterized by a zero and nonzero atomic density difference across the junction respectively. Here, we monitor the dynamics resulting in the system when, in addition to the the above constant velocity protocol, the position of the barrier is periodically driven. We demonstrate that the time-average particle imbalance features a step-like behavior that is the analog of Shapiro steps observed in driven superconducting Josephson junctions. The underlying dynamics reveals an intriguing interplay of the vortex and phonon excitation, where Shapiro steps are induced via suppression of vortex growth. The system is studied through a classical field dynamics scheme in which quantum and thermal fluctuations are taken into account. Results are benchmarked by comparing our findings with a driven circuit dynamics.

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Session Classification: Poster Session III

Track Classification: Superfluidity and Supersolidity