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**Self-trapping bifurcation drives macroscopic-superposition in double well Josephson oscillations.**[1] SHANE KELLY, Univ of California - Riverside, EDDY TIMMERMANS, Los Alamos National Lab, SHAN-WEN TSAI, Univ of California - Riverside — Double well BEC-tunneling exhibits two distinct oscillatory modes: free oscillations around a zero population imbalance and self-trapping oscillations around a nonzero population imbalance. Distinct eigen-state sectors are associated with each of the oscillation behaviors and the sectors are separated by a bifurcation point. We predict (and have numerically observed) that an initial semi-classical state which overlaps with both sectors displays interference between the two oscillatory modes and evolves a macroscopic supper-position state. The interference between the two oscillations is most clearly observed by an asymmetry biased toward free oscillations. By quantifying the divergence from the classical mean-field state, we found the state with maximum non-classical structure produced during its time-evolution. Initial states which have asymmetric evolution also evolve into maximally non-classical states with macroscopic superposition. For the most asymmetric oscillations, the macroscopic superposition is significant for over a quarter of a period and observable by an experiment that, after a given time, interval counts the number of atoms in one of the wells.

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