Noise-Induced Relaxation and Coherence Dynamics in a Bosonic Josephson Junction

Avinaba Mukherjee[1, *] and Raka Dasgupta[1, †]

[1]*Department of Physics, University of Calcutta,* 92 *A. P. C. Road, Kolkata* 700009*, India*

(Dated: April 18, 2025)

We investigate the dynamics of atomic and molecular bosons weakly coupled via Feshbach detuning in a standard Bosonic Josephson Junction (BJJ). The population imbalance between the two species is analyzed as a component of the Bloch vector. When the coupling strength and detuning are subjected to white Gaussian noise, the system exhibits relaxation of the Bloch vector toward a stable equilibrium. Under these conditions, the relaxation rates in the mean field (MF) approximation are found to be greater than those predicted by the Bogoliubov Born Green Kirkwood Yvon (BBGKY) hierarchy. Additionally, within the BBGKY framework, the fringe visibility quantified by the transverse length of the Bloch vector increases, while the Von Neumann entropy decreases, indicating enhanced coherence.

* avinaba.mukherjee@rediffmail.com

† rdphy@caluniv.ac.in

[1] **Relaxation dynamics in a stochastic bosonic Josephson junction**
D. Stefanatos, and E. Paspalakis, Phys. Lett. A **383**, 2370-2375 (2019)

[2] **Decoherence and entanglement in a bosonic Josephson junction : Bose-enhanced quantum zeno control of phase diffusion**
Y. Khodorkovsky, G. Kurizki, and A. Vardi, Phys. Rev. A **80**, 023609 (2009)

[3] **Noise-Induced Relaxation and Coherence Dynamics in a Bosonic Josephson Junction**
A. Mukherjee, R.Dasgupta, Manuscript under preparation.