Dynamic Responses of Parameter-Tuned Nonlinear Oscillator Arrays Under Harmonic Excitation

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Abstract

This study investigates the dynamic complexities of a linear arrangement of 10 coupled nonlinear oscillators under harmonic excitation, examining how tailored structural properties affect both individual oscillators and collective behavior. Each oscillator is represented by a Duffing system, modeled experimentally with a cantilever beam fixed at one end and a magnet at the free end, positioned within the magnetic field of a second fixed magnet. By adjusting the relative orientation and distance between these magnets, we achieve precise control over linear and nonlinear stiffness properties. Leveraging recent advancements in material science and manufacturing, this research systematically explores an extensive range of parameters through analytical, numerical, and experimental methods. Our findings provide a deeper understanding of how tunable parameters influence the system's dynamic response, revealing complex behaviors, including energy localization and varied amplitude responses. Addressing a significant gap in nonlinear oscillator research, this study demonstrates how strategic parameter tuning enhances control over dynamic responses, with broad implications for developing adaptable and responsive systems in nonlinear dynamics.

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