



MECHANICAL ENGINEERING MSc SEMINAR (30 min.)

Monday, July 13 2026 at 16:00-17:30, Lady Davis Building, Room 433

Bilinearly-Induced Localized Modes

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Intrinsic localized modes (ILMs), or discrete breathers, constitute a fundamental class of spatially localized, time-periodic solutions in nonlinear dynamical systems capable of sustaining energy localization in spatially extended homogeneous settings. In classical settings, ILMs typically arise via the amplitude–frequency dependence of smooth nonlinear oscillations, which detunes the localized mode from the linear spectrum and suppresses resonant interactions.

This study reports a fundamentally different class of localized states, termed Bilinearly-Induced Localized Modes (BILMs), discovered within a perfectly homogeneous two-degree-of-freedom bilinear oscillator system. The model incorporates on-site bilinear springs featuring a strong stiffness switching asymmetry between tension and compression at the point of zero deflection. Crucially, this structural configuration renders the system's solutions invariant under amplitude scaling. This unique property ensures that all modal frequencies remain entirely amplitude-independent, similar to linear systems. Consequently, the conventional mechanism of nonlinear localization driven by amplitude–frequency detuning is strictly excluded. Instead, localization is structurally induced by the directional stiffness asymmetry inherent to the bilinear interaction law.

We demonstrate analytically and numerically that the system admits a unique family of BILMs characterized by a strongly asymmetric spatial structure. In these states, a single oscillator undergoes large-amplitude periodic oscillations with repeated zero crossings, while the adjacent oscillator remains permanently confined to shifted, small-amplitude oscillations without zero crossings. This establishes a single-sided dynamical organization of motion within an otherwise homogeneous framework. We construct these solutions in exact analytical form, deriving their parametric zones of existence across both the vibro-impact limit and the finite-stiffness regime. Furthermore, using a Floquet analysis framework extended to non-smooth systems, we map their stability boundaries. The analytical predictions show excellent agreement with direct numerical simulations conducted via Matlab's ODE45 solver.