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Analysis of Transitions Across Distinct Resonant Regimes

Resonant effects are a fundamental driver underlying a broad range of natural phenomena, from fluid and acoustic to optical and biological systems. They are characterized by the amplification of an input signal at or near a fundamental resonant frequency as determined by underlying properties of the system. While the immediate implications in specific cases are well understood, the more general relationship between input and resonant response poses a much more significant challenge and depends intricately on detailed features of the underlying model systems. In particular, based on the ways in which the modal spectrum and nonlinear effects interact, it is well known that qualitatively distinct resonant regimes can emerge with vastly differing characteristics including amplitude and profile of response. Using the parametric variation of a simple one dimensional nonlinear wave model on a bounded domain, I will firstly illustrate how qualitatively distinct outcomes may arise and their contrasting features. Then, in the context of resonantly forced acoustic waves in closed, cylindrical geometries, I will show how a continuous transition between two qualitatively distinct limiting regimes can be achieved and studied in detail.