Critical transitions in asymptotically slow-fast systems

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Abstract: We discuss a geometric approach to the study of bifurcation and rate induced transitions in a class of *asymptotically slow-fast systems*, which are in some sense 'intermediate' between the (smaller resp. larger) classes of asymptotically autonomous and non-autonomous systems. After showing that the relevant systems can be viewed as singular perturbations of a limiting system with a discontinuity in time, we consider an analytical framework for their analysis based on geometric blow-up techniques. Using this approach, we provide sufficient conditions for the occurrence of bifurcation and rate induced transitions in low dimensions, as well as sufficient conditions for tracking in arbitrary (finite) dimensions, i.e. the persistence of an attracting and normally hyperbolic manifold through the transitionary regime. The proofs rely on geometric blow-up, a variant of the Melnikov method which applies on non-compact domains, and general invariant manifold theory. We conclude by applying these results to a low-dimensional problem with forward and backward attractors that feature slow but non-constant dependence on time.

References:

[1] S. Jelbart. Rate and bifurcation induced transitions in asymptotically slow-fast systems. To appear in SIAM Journal on Applied Dynamical Systems, (2024). arXiv:2401.08482.