Breakdown of invariant curves and resonance structure in phase-amplitude response maps

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Computational tools to provide an accurate prediction of phase variations in an oscillator subjected to external stimuli have been recently developed. We have built-in a method based on the concepts of isochrons, *Phase Response Functions* (PRF) and *Amplitude Response Functions* (ARF). In particular, the method can be applied to neurons in a state of repetitive firing. In the special case of a pulse-train periodic stimulus, the application of this theoretical frame leads to a 2D map, one varible controlling phase jumps the other controlling amplitude jumps. Comparisons with the PRC-approach (a 1D map) have already been studied; they report differences up to two orders of magnitude in favor of the 2D predictions, specially when the stimulation frequency is high or the strength of the stimulus is large. Apart from the comparison between 1D and 2D predictions, we have observed (in simulations) interesting bifurcations in the 2D maps that do not occur when using 1D prediction maps; these bifurcation features enlighten the contribution of transient effects in predicting the phase response and show the limits of the phase reduction approach. We have recently gone inside these bifurcation structure and performed a finer study of the persistence and computation of the invariant curves of these 2D maps in an analytico-numerical way. They provide a closer idea of the phase-locking properties within the invariant curves and information about the influence of the stimulus amplitude on their breakdown.