Phase Resetting in the Yamada Model of a *Q*-Switched Laser

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Phase resetting is a technique used to investigate how the phase of an oscillating system is altered, or "reset", due to an external perturbation. A perturbation results in the phase of an oscillating system being advanced or delayed relative to that of the unperturbed system. The resulting phase shift is often portrayed in the form of a phase-transition curve (PTC), showing the relationship between the point at which the perturbation is applied, θ_{old}, and the shifted phase, θ_{new}, where each phase specifies a point on the underlying stable periodic orbit.

In this work we investigate the phase resetting of a self pulsing laser, also known as a *Q-switched* laser featuring a gain and a saturable absorber section. We study a specific model due to Yamada consisting of a set of three coupled ordinary differential equations for the gain G, the absorption Q, and the laser intensity I. The question we address here is how the regular self-pulsating behaviour of this *Q*-switched device is affected by perturbations, given as external impulses in intensity or gain. We take a dynamical systems approach and employ recently developed methods based on the numerical continuation of boundary value problems in the MATLAB based software `COCO`.

We present an analysis of computed PTCs for different perturbation amplitudes and directions to demonstrate how the different invariant objects in the three-dimensional phase space affect the reset phase. We also present the first computation of a two-dimensional isochron surface, consisting of all points that have the same eventual phase.