Complex oscillations in mathematical models of calcium dynamics

Emily Harvey

Supervisors: Dr Vivien Kirk, Prof James Sneyd

Abstract

The dynamics of calcium (Ca^{2+}) is known to play a crucial role in many types of cellular functioning. In particular, in many cells the intracellular Ca^{2+} concentration is seen to oscillate with a wide range of frequencies but with little change in amplitude. These oscillations are thought to act as signals within and between cells, with the signal being encoded in the frequency of the oscillations. A key characteristic of cellular calcium dynamics found experimentally is that it often features long periods of quasi-steady behaviour interspersed with bursts of rapid change. This is seen as evidence of there being multiple timescales in the system.

It has recently been shown that in systems with two or more slow timescales complicated oscillatory patterns known as *mixed-mode oscillations* (MMOs) can arise. This is of interest in calcium dynamics as in the presence of MMOs the frequency of oscillations, and hence the cellular signal, can vary drastically in response to a very small change in parameter values. In this talk I will describe how models of intracellular calcium dynamics are commonly constructed and demonstrate the presence of MMOs in a few key models. I will then show how the existence of these MMOs are due the presence of special solutions called *canards* and will outline the method used for identifying and understanding these canard solutions.