The problem

- We have lots of differential equations for modelling neurons
- Differential equations allow us to understand neural excitability, spiking and bursting in terms of bifurcations
  - A bifurcation is a manifold in parameter space where system dynamics change
- Nonlinear dynamics gives us some excellent tools for studying these differential equation bifurcations
  - This has given us lots of insights into neuronal dynamics
- Issue: all these insights are from mathematical models, not real cells!
  - What if the models don't properly capture the physics? What if neuronal dynamics are more diverse than our models claim?

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The goal

- Nonlinear dynamics uses numerical continuation to study bifurcations in models
- Control-based continuation (CBC) extends numerical continuation for use with physical systems
  - Demonstrated successfully on nonlinear mechanical systems
  - Yet to be tested on biological experiments
- Goal: use control-based continuation to perform an experimental bifurcation analysis of neurons
  1. Develop the CBC methodology for applications to biological systems
  2. Design an experimental setup for controlling live neurons
  3. Perform an experimental bifurcation analysis of living cells