

**Exercise: line simulator for pitchfork bifurcation**

The dynamics simulated in the simulator `tutoriallinesimulator` is

$$\dot{v}(t) = \alpha v(t) - \gamma v^3(t) + q\xi(t)$$

where  $\xi$  is gaussian white noise of zero mean and unit variance,  $\alpha$  and  $\gamma > 0$  are model parameters.

1. Determine the fixed points and discuss their stability on paper. Formulate hypotheses about the dynamics.
2. Familiarize yourself with the simulator.
3. Set  $\alpha < 0$ ,  $\gamma > 0$  and vary the initial condition, observing the asymptotic state (no noise).
4. Set  $\alpha > 0$ ,  $\gamma > 0$  and vary the initial condition, observing the asymptotic state (no noise).
5. Vary noise strength. Compare fluctuations during relaxation to fluctuations in asymptotic state.
6. Vary the size of  $\alpha$ , observe the relaxation behavior in all regimes.
7. Vary the `timestep`. Observe the breakdown of the numerics for large time step.
8. Set  $\alpha > 0$ ,  $\gamma > 0$  and start with  $v = 0$ , no noise. Now add noise.