Subunit exchange *synchronises* cluster of CaMKII bistables

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Abstract

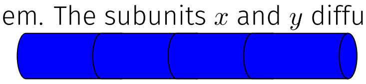
In this experiment, we enable diffusion on subunit x and y; and check its impact on switch behaviour. We find that system of N switches tend to synchronize with each other. Thereby making the cluster of bi-stables to behave like a one bistable switch.
[1]

See figure **??** in section **??**.

1 Experiment

We construct a 'good' bistable switch with 6 CaMKII rings and 27 PP1 (see file `./CMakeLists.txt`) in a cylinder of length 150×10^{-9} m and radius of 30×10^{-9} m (volume = $4.241\,16 \times 10^{-22}$ m^3). This configuration shows a good bistable behaviour.

We assemble N (=3) switches together and setup diffusion of subunit among them. The subunits x and y diffuse between compartments as shown below.



We run the simulation for different values of diffusion coefficients.

[1]This is in contract to our previous study with simple Markov chain based bi-stables which predicted that system of N switches likely to act as one *almost always ON* monostable switch.

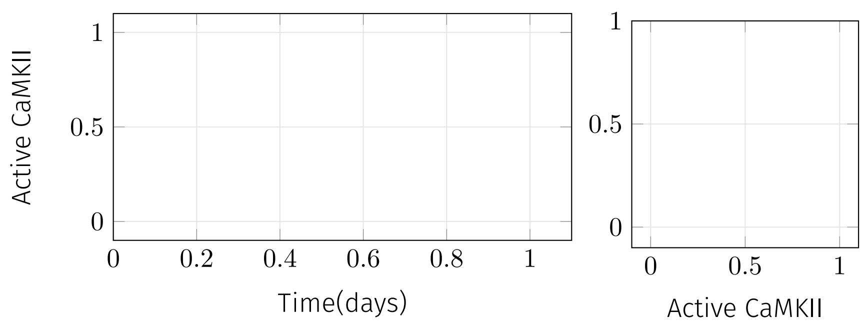


Figure 1: Diffusionn coefficient 0 µm^2/s.

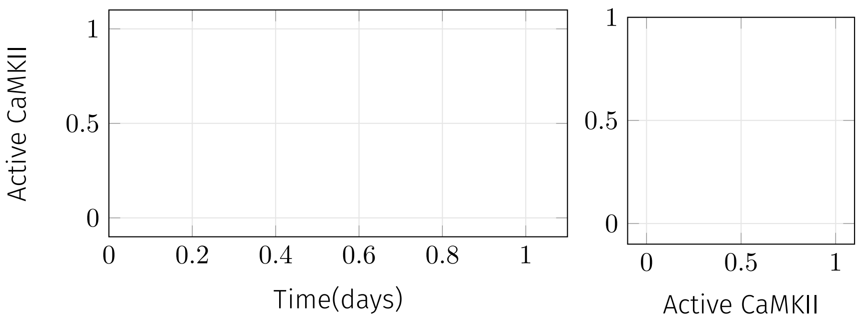


Figure 2: Diffusionn coefficient 1×10^{-18} μm^2/s.

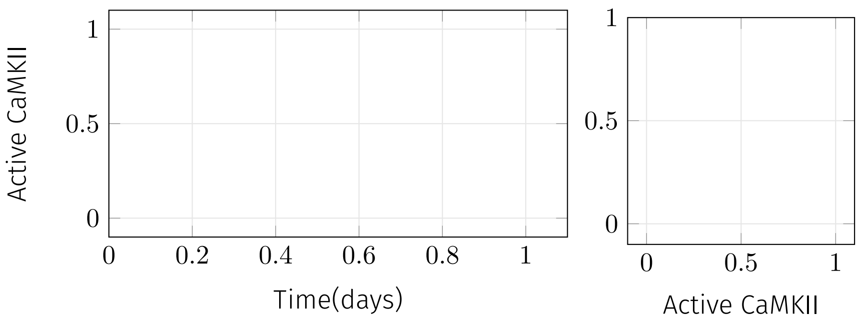


Figure 3: Diffusionn coefficient 1×10^{-15} μm^2/s.

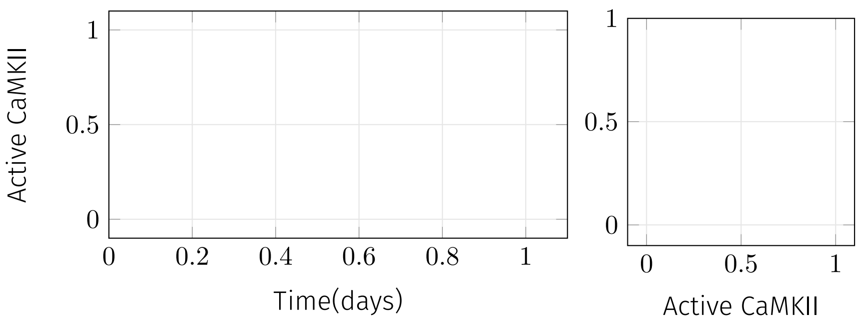


Figure 4: Diffusionn coefficient 1×10^{-14} μm^2/s.

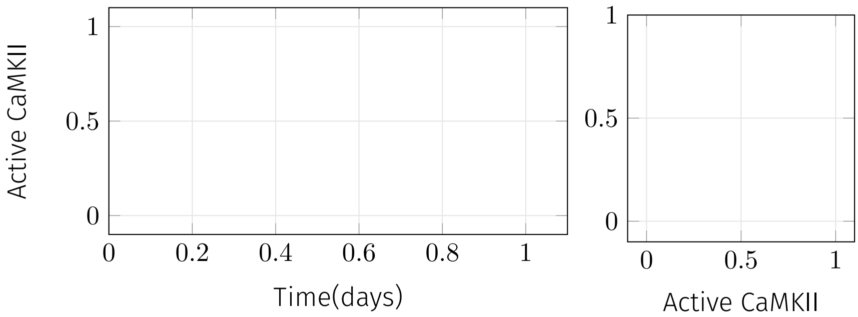


Figure 5: Diffusionn coefficient 1×10^{-13} μm^2/s.

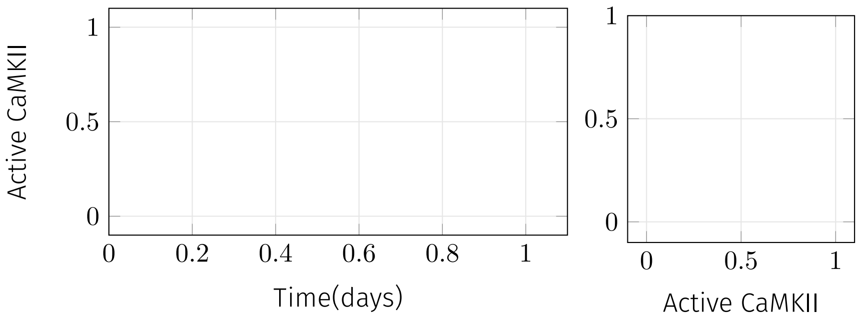


Figure 6: Diffusionn coefficient 1×10^{-12} μm^2/s.

2 Result

2.1 Mean and variation of CaMKII activity vs diffusion coefficient

The most important result from this experiment is the following.

When subunit exchange is enabled in a system of N CaMKII bistables, all bistables in the system 'synchronizes' their switching making the system a single bistable switch.

Figure **??** shows that intermediate states of N switches becoming increasing scarce upon increasing the coupling among switches.

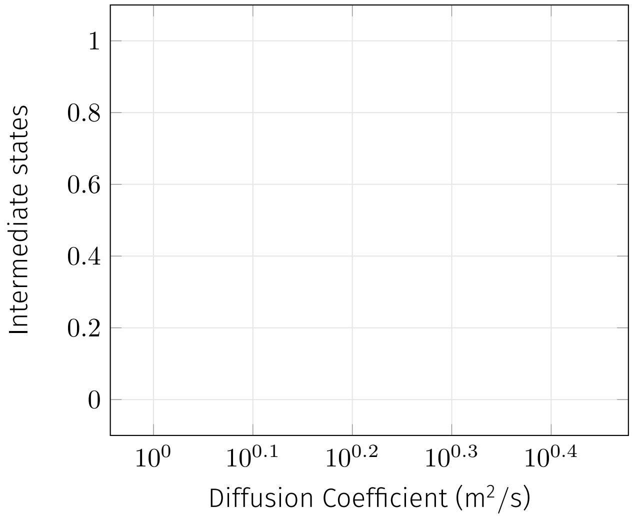


Figure 7: Intermediate states become scarcer as we increase the 'coupling' among switches. Large diffusion coefficient increases the coupling among switches by making subunit exchange faster.