Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Controlling chaos in balanced neural circuits with input spike trains RAINER ENGELKEN, FRED WOLF, MPI for Dynamics and Self-Organization, Goettingen, Germany, BCCN Gttingen, Germany, University of Goettingen, Germany — The cerebral cortex can be seen as a system of neural circuits driving each other with spike trains. Here we study how the statistics of these spike trains affects chaos in balanced target circuits.
Earlier studies of chaos in balanced neural circuits either used a fixed input [van Vreeswijk, Sompolinsky 1996, Monteforte, Wolf 2010] or white noise [Lajoie et al. 2014].
We study dynamical stability of balanced networks driven by input spike trains with variable statistics. The analytically obtained Jacobian enables us to calculate the complete Lyapunov spectrum. We solved the dynamics in event-based simulations and calculated Lyapunov spectra, entropy production rate and attractor dimension. We vary correlations, irregularity, coupling strength and spike rate of the input and action potential onset rapidness of recurrent neurons.
We generally find a suppression of chaos by input spike trains. This is strengthened by bursty and correlated input spike trains and increased action potential onset rapidness. We find a link between response reliability and the Lyapunov spectrum. Our study extends findings in chaotic rate models [Molgedey et al. 1992] to spiking neuron models and opens a novel avenue to study the role of projections in shaping the dynamics of large neural circuits.

Rainer Engelken
MPI for Dynamics and Self-Organization, Goettingen, Germany

Date submitted: 06 Nov 2015 Electronic form version 1.4