Fluctuations in strongly coupled soft-threshold integrate-and-fire networks | Gabriel Koch Ocker

Authors: Gabriel Koch Ocker, Department of Mathematics and Statistics, Boston University; Michael A. Buice; Allen Institute.

Neuronal activity is striking for its variability. One potential source of this variability is the strong and heterogeneous synaptic connectivity of neurons. Here, we study strongly-coupled networks of integrate-and-fire neurons with stochastic spike emission. Using a statistical field-theoretic formalism, we calculate the Dyson-Schwinger equations for this model: an infinite hierarchy of equations governing moments of the neurons' membrane potentials and/or spike trains and their input responses. We use these to derive a set of fluctuation-response relations that relate subthreshold and spiking variability to responses to sub- or suprathreshold perturbations. We then examine a transition to internally-generated fluctuating activity in strongly-coupled networks using both weakly and strongly nonlinear (one-loop and dynamical mean-field) Gaussian approximations, and compare the roles of stochastic spike emission and strong coupling in shaping the variability.