Chaos and correlated avalanches in excitatory neural networks with synaptic plasticity

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A collective chaotic phase with power law scaling of activity events is observed in a disordered mean field network of purely excitatory leaky integrate-and-fire neurons with short-term synaptic plasticity [1]. The dynamical phase diagram exhibits two transitions from quasi-synchronous and asynchronous regimes to the nontrivial, collective, bursty regime with avalanches. In the homogeneous case without disorder, the system synchronizes and the bursty behavior is reflected into a doubling-period transition to chaos for a two dimensional discrete map. Numerical simulations show that the bursty chaotic phase with avalanches exhibits a spontaneous emergence of persistent time correlations and enhanced Kolmogorov complexity. Our analysis reveals a mechanism for the generation of irregular avalanches that emerges from the combination of disorder and deterministic underlying chaotic dynamics.

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[1] F. Pittorino, M. Ibáñez-Berganza, M. di Volo, A. Vezzani and R. Burioni, Phys. Rev. Lett. 118 (2017), 098102-6.