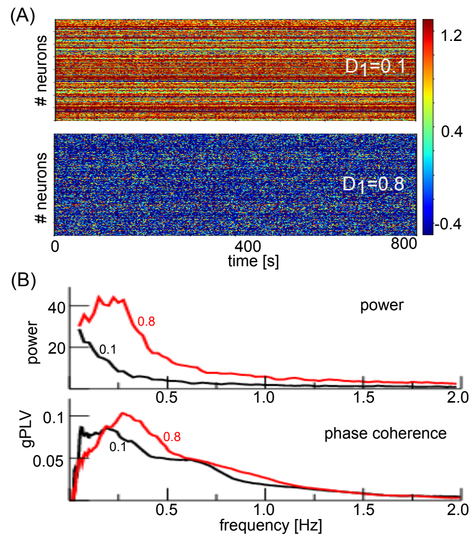

Figure A1: Additive noise induces phase coherent oscillations in networks of low mean degree $cN = 50$. (A) activity $V_n(t)$ at $D_1 = 0.1$ (low noise level) and $D_1 = 0.8$ (high noise level). (B) power spectrum of $\bar{V}$ (top panel) and global phase coherence (bottom panel) for both noise levels. It is $c = 0.25$ and $N = 200$, other parameters are taken from Fig. 4.

A Appendix: Low mean degree

The stochastic analysis method presented allows to describe the effect of strong noise on excitation-inhibition interaction networks. In sum, the method assumes the validity of the mean-field approach that implies Eq. (12), i.e. the independence of the connectivity and mean-field deviations. The validity of condition (12) is based on a sufficiently large number of connections of each note, which is the mean degree cN. Numerical simulations shown in Fig. 4 and 6 consider a large mean degree $cN = 475$. To demonstrate that our analysis method is valid for different parameter sets, e.g. a smaller mean degree, Figure A1 shows numerical simulations for the same noise levels D_1 as in Fig. 4, but with a much smaller mean degree $cN = 50$. We observe equivalently two equilibria for different noise levels and corresponding enhanced power and global phase coherence in the noise-induced state for $D_1 = 0.8$. This affirms the findings in the main text.

Finally, we mention that preliminary numerical simulations at lower mean degree $cN \leq 40$ (not shown) do not agree with the analytical findings since condition (12) does not hold anymore due to a too low mean degree. This finding may motivate further studies but these would exceed the major aim of the present work.