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Collective fluctuations in networks of noisy components

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Collective dynamics result from interactions among noisy dynamical components. Examples include heartbeats, circadian rhythms, and various pattern formations. Because of noise in each component, collective dynamics inevitably involve fluctuations, which may crucially affect functioning of the system. However, the relation between the fluctuations in isolated individual components and those in collective dynamics is unclear. Here we study a linear dynamical system of networked components subjected to independent Gaussian noise and analytically show that the connectivity of networks determines the intensity of fluctuations in the collective dynamics. Remarkably, in general directed networks including scale-free networks, the fluctuations decrease more slowly with the system size than the standard law stated by the central limit theorem.

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