Effects of Geometrical Structure on Dynamics on Complex Networks

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We present a study of the effects of the geometrical structure of complex networks on dynamical systems running on top of them. Networks can be classified as planar or non-planar, depending on wheter they can be embedded on a two-dimensional plane or not. In the case of planar networks, they somehow inherit the geometrical properties of the embedding plane, which are expected to show up in the properties of dynamical systems running on top of them. Focusing on two of the simplest dynamical systems, the reaction-difusison processes $A + A \to 0$ and $A + B \to 0$, we study the effects of planarity in their time evolution. Previous works on these models demonstrated that, at a mean-field level, these dynamics depend on the connectivity of the networked substrate, and in particular, on their degree distribution $P(k)$ [**?**, **?**]. Moreover, it has been also argued [**?**] that the dynamics depends on the minimun degree in the network. This fact has been further investigated [**?**] and the discrepancies found have been attributed to the tree-like structure exhibited by some network models with minimum degree $m = 1$. In this work, we show that these effects are, in fact, more general and typical of planar networks, of which trees are a particular case. We present evidence that dynamical systems show a different behavior in planar and non-planar networks. In the latter case, this behavior is well captured by mean-field theory, which implicitly neglects all possible geometrical effects [**?**]. In the former case, instead, non-mean-field behavior is observed. This different behavior can be attributed to the diffusive nature of the dynamical models considered: in planar networks, diffusion is slowed down, due to the multiple bottlenecks present in the networks.

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