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ROBUSTNESS AND FRAGILITY OF THE SUSCEPTIBLE-INFECTED-SUSCEPTIBLE EPIDEMIC CHAIN ON NETWORKS

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One of the most basic but still surprising model to investigate epidemic spreading in networks is the susceptible-infected-susceptible (SIS). Infected agents lying on the nodes of a network become spontaneously healed (susceptible) with rate μ and infect a susceptible contact with rate λ. There is a phase transition between a disease-free (absorbing) state and an active stationary phase, defining a epidemic threshold λ_c. This epidemic threshold is formally zero in the thermodynamical limit for random networks with a power-law (PL) degree distribution $P(k) \sim k^{-\gamma}$. However, real and computationally generated networks are finite, so the finite-size dependence is fundamental and usually done by mean-field approximations, such as the degree-based heterogeneous mean-field (HMF) and the individual-based quenched mean-field (QMF). The mutual activation of hubs is a mechanism that can explain the trigger of the epidemic, remaining active for a sufficient time to infect each other. In this work, the robustness of this activation mechanism is investigated by modifying slightly the standard SIS model while preserving its fundamental properties. The thresholds are the same for both HMF and QMF theories, while the mutual reinfection time of hubs predicts a finite threshold in the thermodynamical limit for $\gamma > 3$ in the modified versions. Statistically exact simulations on large synthetic networks corroborate this finite threshold. For $\gamma < 3$, the modified dynamics present a vanishing threshold in better agreement with HMF instead of QMF. Our results relight the discussion of the choice of suitable theoretical approaches and the conception of epidemic modeling to describe real systems. The authors acknowledge the financial support by the Brazilian agencies FAPEMIG, CAPES and CNPq.

References

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