ABSTRACT BOOK

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References

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Asymmetrically interacting contagion: role of time scale

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Diseases and other contagion phenomena in nature and society can interact asymmetrically, such that one can benefit from the other, which in turn impairs the first, in analogy with predator-prey systems. One of the most studied examples is the asymmetrical interaction between disease and information spreading on human populations, where information about the disease is promoted during an outbreak and helps individuals to take protective measures [1]. For pathogen-pathogen interactions, there are reports of in-host HIV viral load suppression by the presence of other pathogens, such as the dengue virus (DENV) [2], measles [3] and others, suggesting that some diseases undergo an asymmetrical interaction that is currently neglected on population-level epidemic modeling.

Here, we consider two models for interacting disease-like dynamics with asymmetric interactions and different associated time scales. By time scale, we mean the typical rates (or periods) of infection and healing, which can be short (e.g. a few days for influenza, dengue and rumors, but months or years for AIDS and tuberculosis). The two models are similar in that they consider a positive-negative interaction between two pathogens, but different with respect to the interaction mechanism. We use rate equations for homogeneously mixed populations to characterize the fundamental dynamics, and employ analytical and numerical methods to study them. We analytically calculate the stationary prevalences and phase diagrams of each model, and show that they behave differently under variations of the relative time scales. We also characterize the regime where transient oscillations are observed, a pattern that is inherent to asymmetrical interactions but often ignored in the literature of epidemic models. The relative time scale considerably impacts the oscillatory behavior. Finally, we show that, for one of the models, there is an optimal value of the interaction coupling that maximizes the spreading of the "predator" disease. Our results contribute to a better understanding of disease dynamics in particular, and interacting processes in general, and could provide interesting insights for real-world applications.

References

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An epidemiological model with voluntary quarantine strategies governed by evolutionary game dynamics

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