Stochastic epidemic models: from finite size corrections to Hamiltonian formulations

Gilbeto M. Nakamura[1,2] **and Alexandre S. Martinez**[1,2]

[1] *University of São Paulo (USP), Av. Bandeirantes, 3900, 14040-901, Ribeirão Preto, SP, Brazil*

[2] *Instituto Nacional de Ciência e Tecnologia em Sistemas Complexos (INCT-SC), Brazil*

gmnakamura@usp.br

asmartinez@usp.br

Recent experiments in controlled environments have shown evidence that correlated noise can increase the prevalence of diseases under certain conditions. Despite the various advances in the mathematical modelling of epidemics, the full extent of stochastic effects remains poorly known, due to the non-linearity of the problem. The issue becomes even worse for small populations, where stochastic effects are enhanced. Here, we discuss finite size effects and the interplay between temporal fluctuations and disease prevalence in the stochastic SIS model in discrete time. The equations of motion for mean prevalence and variance are derived and compared with Monte Carlo simulations. In the small perturbation regime, we show the model satisfies Hamilton's equations in continuous time. Our findings offer new insights about epidemic models subjected to fluctuations, and can be used to evaluate symmetries and constants of motion, including the relaxation time of the outbreak.

References

[1] A. B. Duncan, A. Gonzalez and O. Kaltz, Stochastic environmental fluctuations drive epidemiology in experimental host-parasite metapopulations. Proc. Royal Soc. B 280, (2013).

[2] G. M. Nakamura, A. C. P. Monteiro, G. C. Cardoso and A. S. Martinez, Efficient method for comprehensive computation of agent-level epidemic dissemination in networks. Sci. Rep. 7, (2017).

[3] G. M. Nakamura, N. D. Gomes, G. C. Cardoso and A. S. Martinez, Robust parameter determination in epidemic models with analytical descriptions of uncertainties. ArXiv 1807.05301, (2018).