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Susceptible-infected-recovered model with recurrent infection

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Abstract

We analyze a stochastic lattice model describing the spreading of a disease among a community composed by susceptible, infected and removed individuals. A susceptible individual becomes infected catalytically. An infected individual may, spontaneously, either become recovered, that is, acquire a permanent immunization, or become again susceptible. The critical properties including the phase diagram is obtained by means of mean-field theories as well as numerical simulations. The model is found to belong to the universality class of dynamic percolation except when the recovering rate vanishes in which case the model belongs to the directed percolation universality class.

Key words: epidemic models, nonequilibrium phase transitions, dynamic percolation, SIR model

1 Introduction

The spreading of diseases and, more generally, the dynamics of populations are described by models that can be characterized as being deterministic or stochastic, space structured or non-space structured [1–9]. An important model that has been studied by each one of these approaches is the so-called susceptible-infected-recovered (SIR) model [5–22]. The SIR model describes the spreading of a disease in a community in which individuals acquire permanent immunization. A susceptible (S) individual becomes infected (I) by the contact with and infected individual, a process interpreted as a catalytic reaction, S+I $\rightarrow$ I+I. An infected individual may eventually recover from the

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