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Analysis of an SIRS Epidemic Model for a Disease Geographic Spread

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Abstract: An SIRS epidemic model for the geographic spread is considered. The linear stability analysis is conducted to obtain the threshold condition and a super-critical instability region is found whenever the reproduction number $\mathcal{R} > 1$. An evolution equation for the leading order of infectives is derived by the long wave-length expansion method and full pattern formation analysis is carried out. The Poincaré-Lindstedt method is applied to obtain a uniformly periodic valid solution. Numerical simulations are used to present the results.

Keywords: *evolution equation; SIRS; stability; pattern formation; Poincaré-Lindstedt method.*

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1 Introduction

In epidemiology the use of mathematical models starts from the pioneering works of Kermack and McKendrick [1–4]. To describe the Great Plague of London of 1665-1666, Kermack and McKendrick use a simple basic deterministic differential equation model called the SIR model [3], [4]. Many mathematical models in the literature are built based on the modeling framework of Kermack and McKendrick.

Most of existing studies rely on different types of differential equations. For instance, first-order partial differential equations are used for modeling of age structures [5–8]; delay-differential equations or integral equations are suitable when time delay or delay factors appear [9–13]; second-order partial differential equations are more realistic when a diffusion term exists.

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