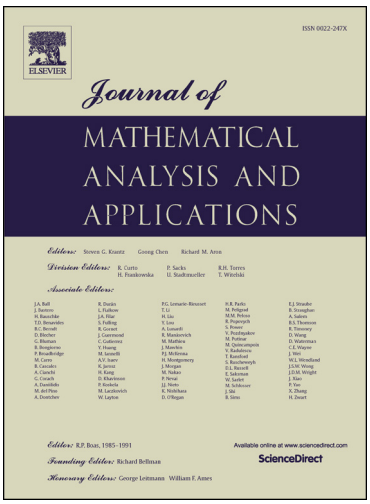
Accepted Manuscript



Positive steady states of reaction-diffusion-advection competition models in periodic environment

Yin-Liang Huang, Chang-Hong Wu

PII: S0022-247X(17)30380-3
DOI: http://dx.doi.org/10.1016/j.jmaa.2017.04.026
Reference: YJMAA 21313

To appear in: *Journal of Mathematical Analysis and Applications*

Received date: 20 December 2016

Please cite this article in press as: Y.-L. Huang, C.-H. Wu, Positive steady states of reaction-diffusion-advection competition models in periodic environment, *J. Math. Anal. Appl.* (2017), http://dx.doi.org/10.1016/j.jmaa.2017.04.026

POSITIVE STEADY STATES OF REACTION-DIFFUSION-ADVECTION COMPETITION MODELS IN PERIODIC ENVIRONMENT

YIN-LIANG HUANG AND CHANG-HONG WU

Abstract. In this paper, we consider the positive steady states for reaction-diffusion-advection competition models in the whole space with a spatially periodic structure. Under the spatially periodic setting, we establish sufficient conditions for the existence of positive steady states of this model, respectively, by investigating the sign of the principal eigenvalue for some linearized eigenvalue problems. As an application, a Lotka-Volterra reaction-diffusion-advection model for two competing species in a spatially periodic environment is considered. Finally, some numerical simulations are presented to seek dynamical behaviors.

1. Introduction

In ecological modeling or the management of invasive species, one interesting aspects is to understand how fragmented environments influence the persistence and extinction of species. A typical mathematical model in a spatially periodic environment (see [25, 37, 38]) is

$$u_t = (d(x)u_x)_x + u(m(x) - u), \quad x \in \mathbb{R},\ t > 0, \tag{1.1}$$

where $u(x,t)$ represents the population density of the species; $d(x)$ is the diffusion coefficient and $m(x)$ stands for the intrinsic growth rate of species or the resource used to measure the quality of the environment. Moreover, d and m are both periodic functions. Empirically, it has been found that the stability of the trivial state plays an important role to influence the persistence of population. A classical work done by Berestycki, Hamel and Roques [5] studied the general case of (1.1) (see also [21]). They gave a complete and rigorous mathematical analysis and also provided abundant biological insights. More precisely, they investigated the existence, uniqueness of stationary solutions and the long-time behavior of solutions to the following equation

$$u_t = \nabla \cdot (A(x)\nabla u) + f(x,u), \quad x \in \mathbb{R}^n,\ t > 0 \tag{1.2}$$

where the diffusion matrix A and the reaction term f are periodic in x, $f(x,0) = 0$ and

(i) $f(x,s)/s$ is decreasing in s for any fixed $x \in \mathbb{R}^n$;
(ii) There exists $M > 0$ such that $f(x,s) \le 0$ for all $x \in \mathbb{R}^n$ and $s \ge M$.

Date: April 14, 2017. Corresponding author: C.-H. Wu.
Key words and phrases: Positive steady states, reaction-diffusion-advection, population dynamics, periodic environment.