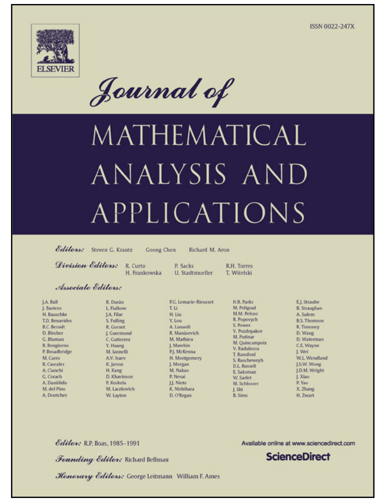

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PII: S0022-247X(18)30632-2
DOI: https://doi.org/10.1016/j.jmaa.2018.07.050
Reference: YJMAA 22441

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

Received date: 3 February 2018

Periodic traveling waves in a reaction-diffusion model with chemotaxis and nonlocal delay effect

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Abstract

In this paper, we study the existence of periodic traveling wave solutions with large wave speed for a reaction-diffusion model with chemotaxis and nonlocal delay effect by applying the perturbation method. The proof relies on an abstract formulation of the wave profile as a solution of an operator equation in a certain Banach space, coupled with the Lyapunov-Schmidt reduction and the implicit function theorem.

Keywords: Reaction-diffusion model; Chemotaxis; Nonlocal delay effect; Periodic traveling waves; Perturbation method.
AMS (2000) Subject Classification: 34G20, 34K13, 34K17, 35K20, 35K57, 92C17, 92D25.

1 Introduction

Chemotaxis is an obvious feature of the population model. This feature plays a great role in living organisms' lives such as locating food and avoiding being preyed upon. Mathematically, chemotaxis is the movement toward higher concentration of some chemical substance, which is modeled by the flow of u in the direction of the gradient of v: $\nabla\cdot(u\nabla v)$, where u and v denote the population density of biological individuals and the concentration of a chemical substance, respectively. In 1996, Mimura and Tsujikawa [19] proposed a reaction-diffusion model

$$\begin{cases} \dfrac{\partial u(x,t)}{\partial t} = d_1\Delta u(x,t) - \alpha\nabla\cdot[u(x,t)\nabla v(x,t)] + \vartheta(u(x,t)), \\ \dfrac{\partial v(x,t)}{\partial t} = d_2\Delta v(x,t) + au(x,t) - bv(x,t), \end{cases} \tag{1.1}$$

which describes the pattern dynamics of biological individuals possessing chemotaxis. Here $x\in\mathbb{R}^N$ is the spatial variable; $t\geq 0$ is the time; u and v denote the population density of biological individuals and the concentration of a chemical substance, which is produced by the individual itself, at position x and time t, respectively; Δ is the Laplacian operator; d_1 and d_2 are the diffusion rates of u and v, respectively; the term $-\alpha\nabla\cdot(u\nabla v)$ denotes chemotaxis, where α is the chemotactic sensitivity; the term $\vartheta(u)$ denotes the proliferation and the reduction due to the death of the individuals; the terms $-bv$ and au denote the degradation and the production of the chemical substance, respectively; d_1, d_2, a, b and α are positive constants. System (1.1) has been investigated by many authors [2, 3, 21, 23, 25].