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LOTKA-VOLTERRA COMPETITION SYSTEM WITH STRONG ADVECTION RATES

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Abstract. A two-species Lotka-Volterra competition model in a strong advective homogeneous environment is explored, modeled by a system of advection-reaction equations. It is assumed that the two species have the same population dynamics but different advection rates. It is shown that the two-dimensional Lotka-Volterra competition model with advection can be written as a three-dimensional dynamical system in traveling wave coordinates, which facilitates the complete derivation of explicit traveling wave solutions. In particular, standing waves arise even in the presence of strong advection provided the advection rates have opposite signs.

Keywords. Lotka-Volterra system; traveling waves; standing waves; advection-reaction equation; population dynamics

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1 Introduction

The effect of interaction between competing species on population survival has been studied for decades, with the first model dating back to Lotka (1932) and Volterra (1926). We shall refer to this as the Lotka-Volterra competition (LVC) model (see for instance [1] and [3] for the mathematical background and exhaustive references).

From the perspective of biological invasion, the diffusive LVC model predicts that the competing species will spread via traveling waves. The LVC model with diffusion is of course well investigated; some results are summarized in [4, 5] for example. Recently, Girardin and Nadin [6] gave analytic conditions on the direction of these traveling waves, relating the competition strength to species diffusivity, which enables the prediction of stable co-existence of two competing populations or which population will survive in the long run in an invasion scenario.

In this article we explore the population dynamics of a two-species LVC system in a strong advective homogeneous environment modeled essentially