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Existence and asymptotic stability of a generic Lotka-Volterra system with nonlinear spatially heterogenous cross-diffusion

This article considers a class of Lotka-Volterra systems with multiple nonlinear cross-diffusion, commonly known as prey-taxis models. The existence and stability of classic solutions for such systems with spatially homogeneous sources and taxis have been studied in one- or two-dimensional space, however, the proof is non-trivial for a more general setting with spatially heterogeneous predation functions and taxis coefficient functions in arbitrary dimensions. This study introduces a new weighted L^p_ϵ -norm and extends some classical inequalities within this normed space. Coupled energy estimates are employed to establish initial bounds, followed by applying heat kernel properties and an advanced bootstrap process to enhance solution regularity. For stability analysis, we extend LaSalle's invariance principle to a general L^∞ setting and utilize it alongside Lyapunov functions to analyze the stability of each possible constant equilibrium. All results are achieved without introducing an extra logistic growth term for predators or imposing smallness conditions on taxis coefficients.