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1 Bifurcation analysis of predator-prey systems with Allee effect

Guanqi Liu (PhD thesis project)

This project is consider a predator-prey system with prey growth having an Allee effect:

\[
\begin{align*}
    u_t &= d_1 \Delta u + \lambda u(1-u)(u-a) - buv, & t > 0, \ x \in \Omega, \\
    v_t &= d_2 \Delta v + \mu v - ev^2 + cuv, & t > 0, \ x \in \Omega, \\
    u(x,0) &= u_0(x) \geq 0, \ v(x,0) = v_0(x) \geq 0, & x \in \Omega, \\
    u(x,t) = v(x,t) &= 0, & t > 0, \ x \in \partial \Omega.
\end{align*}
\]

Here all constants are positive, except possibly \( \mu \) and \( e \). For these two parameters, we assume (i) \( \mu \in \mathbb{R}, \ e > 0 \); and (ii) \( \mu < 0 \) and \( e = 0 \). Also \( a \in (0, 1/2) \). (see [DS2] for more discussions) The question is to study the existence/nonexistence of nontrivial solutions,
and related bifurcation problems. When the Allee affect term is replaced by logistic one, many results are known (see [DS2] for a review). Try to use the same bifurcation strategy in [DS1, DS2], namely using $\mu$ as bifurcation parameter. Here one of semi-trivial solutions satisfies

\begin{equation}
\Delta u + \lambda u(1 - u)(u - a) = 0, \quad x \in \Omega, \quad u = 0, \quad x \in \partial \Omega.
\end{equation}

When $\Omega = B^n$, the solution structure is completely known; for general domain $\Omega$, only partial results are that there exists a maximal solution, and at least another solution for large $\lambda$.

References


2 Uniqueness of positive solution to a singular elliptic equation

(Master thesis project)

This project is to consider the uniqueness of positive solution to the equation considered in [SY], by using the methods in [DSh].

References

3 Sublinear and superlinear elliptic systems

(Master thesis project)

References


4 Global bifurcation in the Brusselator system

(Master thesis project)

References


5 Exact multiplicity of diffusive logistic equation with harvesting

(Master thesis project)
References


6 Numerical studies of non-local logistic equation

(Master thesis project)

References


7 Bifurcation diagram in supercritical problems

(Master thesis project)

References
