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Principal eigenvalue and eigenfunctions of an elliptic operator with large advection and its application to a competition model. (English summary) 


The paper deals with the elliptic problem

\[-\Delta \varphi - 2s \nabla m \cdot \nabla \varphi + c \varphi = \lambda(s) \varphi \quad \text{in } \Omega,\]

\[\partial_n \varphi = 0 \quad \text{on } \partial \Omega, \quad \varphi > 0 \quad \text{on } \bar{\Omega},\]

\[\int_{\Omega} e^{2sm} \varphi^2 dx = 1,\]

where \(m\) and \(c\) are given smooth functions on \(\bar{\Omega}\), \(\Omega\) is a domain in \(\mathbb{R}^N\) with smooth boundary \(\partial \Omega\), \(n(x)\) is the unit exterior normal vector to \(\partial \Omega\) at \(x\), and \(\partial_n \varphi(x) = n(x) \cdot \nabla \varphi(x)\). The asymptotic behavior of the principal eigenvalue and its eigenfunction is studied, as the coefficient \(s\) of the advection term tends to \(+\infty\).

The results are then applied to a Lotka-Volterra reaction-diffusion-advection model for two competing species. The two species have the same growth rate, but different dispersal strategies. One species disperses only by random diffusion, while the other one disperses not only by random diffusion, but also by a directed movement towards more favorable habitat. In addition, the diffusion coefficients are different from each other.

It is shown that the species can coexist when the advection is strong relative to random dispersal. Under some hypotheses, the density of the species with large advection in the direction of resources is concentrated at the location with maximum resources.

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References


Note: This list reflects references listed in the original paper as accurately as possible with no attempt to correct errors.

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