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Spatial movement with diffusion and memory-based self-diffusion and cross-diffusion

Spatial memory has been considered significant in animal movement modeling. We formulate a two-species interaction model by incorporating both random walk and spatial memory-based walk in their movement. The spatial memory-based walk, described by a chemotactic-like term, is derived by a modified Fick's law involving a directed movement toward the gradient of the density distribution function at a past time. For the proposed model, local stability and bifurcations are studied at constant steady states. Unlike a classical reaction-diffusion equation, we show that the accumulation points of eigenvalues for the model will locate at a vertical line in the complex plane, which will make the model generate spatially inhomogeneous time-periodic patterns through Hopf bifurcation. As illustrations, we apply these results to competition and cooperative models with memory-based diffusion. For the competition model, it turns out that the outcomes are far more complicated than those of classic Lotka-Volterra reaction-diffusion models, due to the consideration of memory-based diffusion. In particular, the existence of periodic oscillations is proved under weak competition. Similar conclusions hold for the cooperative model. This is a joint work with Chuncheng Wang and Hao Wang.