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The Stability of Hotspot Patterns for a Continuum Model of Urban Crime and the Effect of Police Intervention

In a singularly perturbed limit, we analyze the existence and linear stability of steady-state localized hotspot solutions for the 1-D three-component reaction-diffusion (RD) system formulated and studied numerically in Jones et. al. [Math. Models. Meth. Appl. Sci., **20**, Suppl., (2010)], which models urban crime with police intervention. In our model, the field variables are the attractiveness field for burglary, the criminal density, and the police density, and it includes a scalar parameter that determines the strength of the police drift towards maxima of the attractiveness field. For a special choice of this parameter, we recover the "cops-on-the-dots" policing strategy of Jones et. al., where the police mimic the drift of the criminals towards maxima of the attractiveness field.

For this model we develop a spectral theory based on the analysis of of nonlocal eigenvalue problems to provide phase diagrams in parameter space characterizing the linear stability of hotspot patterns. In one particular parameter regime, the hotspot steady-states are shown to be unstable to asynchronous oscillatory instabilities in the hotspot amplitudes arising from a Hopf bifurcation. Within the context of our model, this provides a parameter range where the effect of a cops-on-the-dots policing strategy is to only displace crime temporally between neighboring spatial regions. In other parameter regimes, we show that new hotspots of criminal activity can be nucleated in low crime regions when the spatial extent of these quiescent regions exceeds a critical threshold.

Both the mathematical challenges in the linear stability analysis, and the qualitative interpretation of our results are highlighted.