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Stochastic population oscillations in spatial predator-prey models

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It is well-established that including spatial structure and stochastic noise in models for predator-prey interactions invalidates the classical deterministic Lotka-Volterra picture of neutral population cycles. In contrast, stochastic models yield long-lived, but ultimately decaying erratic population oscillations, which can be understood through a resonant amplification mechanism for density fluctuations. In Monte Carlo simulations of spatial stochastic predator-prey systems, one observes striking complex spatio-temporal structures. These spreading activity fronts induce persistent correlations between predators and prey. In the presence of local particle density restrictions (finite prey carrying capacity), there exists an extinction threshold for the predator population. The accompanying continuous non-equilibrium phase transition is governed by the directed-percolation universality class. We employ field-theoretic methods based on the Doi-Peliti representation of the master equation for stochastic particle interaction models to (i) map the ensuing action in the vicinity of the absorbing state phase transition to Reggeon field theory, and (ii) to quantitatively address fluctuation-induced renormalizations of the population oscillation frequency, damping, and diffusion coefficients in the species coexistence phase. [See Preprint arXiv:1105.4242, and further refs. therein.]