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Population oscillations in stochastic Lotka–Volterra models: field theory and perturbational analysis UWE C. TÄUBER, Department of Physics, Virginia Tech — Field theory tools are applied to analytically study fluctuation and correlation effects in spatially extended stochastic predator-prey systems. In the mean-field rate equation approximation, the classic Lotka–Volterra model is characterized by neutral cycles in phase space, describing undamped oscillations for both predator and prey populations. In contrast, Monte Carlo simulations for stochastic two-species predator-prey reaction systems on regular lattices display complex spatio-temporal structures associated with persistent erratic population oscillations. The Doi–Peliti path integral representation of the master equation for stochastic particle interaction models is utilized to arrive at a field theory action for spatial Lotka–Volterra models in the continuum limit. In the species coexistence phase, a perturbation expansion with respect to the nonlinear predation rate is employed to demonstrate that spatial degrees of freedom and stochastic noise induce instabilities toward structure formation, and to compute the fluctuation corrections for the oscillation frequency and diffusion coefficient. The drastic downward renormalization of the frequency and the enhanced diffusivity are in excellent qualitative agreement with Monte Carlo simulation data.

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