Self-similar diffusive equilibration for a coupled reaction-diffusion system with mass-action kinetics

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We study a coupled system of two nonlinear reaction-diffusion equations on the unbounded domain $\mathbb{R}$, where we consider reaction kinetics of the reaction $nX_1 \rightleftharpoons mX_2$ according to the mass-action law. We show the global existence and uniqueness of classical solutions and prove the existence of invariant rectangles, that is, bounded regions $\Sigma \subset \mathbb{R}^2$ in which the solutions stay for all times, provided that the initial data lies entirely in Σ. Further, by assuming that the reaction is equilibrated and that the asymptotic boundary conditions at infinity are given by constant steady-state solutions, the diffusive mixing is studied. Here the theory of self-similar solutions in the sense of Barenblatt is applicable. Combined with the theory of monotone operators, this enables us to prove that there exists for each choice of asymptotic boundary conditions a similarity profile.

This research is joint work with Alexander Mielke.