A Stable Manifold Theorem for a class of degenerate evolution equations and decay of kinetic shock layers

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We establish a Stable Manifold Theorem, with consequent exponential decay to equilibrium, for a class of degenerate evolution equations $Au' + u = D(u, u)$ with A bounded, self-adjoint, and one-to-one, but not invertible, and D a bounded, symmetric bilinear map. This is related to a number of other scenarios investigated recently for which the associated linearized ODE $Au' + u = 0$ is ill-posed with respect to the Cauchy problem. The particular case studied here pertains to the steady Boltzmann equation, yielding exponential decay of large-amplitude shock and boundary layers.