Summary

Driven diffusive models are an attractive research topic for the study of nonequilibrium steady states and for the potential applications to biological and vehicular traffic problems. A reference model in this class is the Totally Asymmetric Simple Exclusion Process (TASEP), for which many exact results have been obtained in the last decades. In this PhD thesis we investigate the relaxation dynamics of two extensions of the TASEP, namely the TASEP with Langmuir kinetics (TASEP-LK) and a TASEP with local interactions called the Antal-Schütz (AS) model. We are mainly interested in studying the dynamical transition, which is characterized by a singularity in the slowest relaxation rate of the system toward the steady state, though not accompanied by any change in the steady state properties. This transition was discovered and exactly located in the phase diagram for the TASEP, it separates one or more *slow* phases, where the relaxation rate depends on a control parameter, from a *fast* phase where the rate reaches a maximum and becomes constant.

Our investigations are based on three different approaches, which provide consistent pictures for both models: the first one corresponds to the mean-field like (cluster) approximations, which reproduce the exact static phase diagram of the TASEP and yield dynamical transition lines in good qualitative agreement with the exact ones. The second method is the modified Domain Wall Theory (mDWT), which is a heuristic correction of the slowest relaxation rate of the DWT in the fast phase and is exact by construction for the TASEP. The last approach consists in computing the exact slowest relaxation rate at finite size and then extrapolating the results to the infinite size limit with the Bulirsch-Stoer (BST) algorithm. It was applied to pure TASEP and gave very accurate results.

As regards the cluster approximations, we develop a mean-field theory for the TASEP-LK with equal (balanced) attachment/detachment rates. This theory predicts the onset of a dynamical transition and allows one to derive analytical bounds for the slowest relaxation rate, becoming tight in the infinite size limit. Then, we extend the analysis to the unbalanced case, where a new type of dynamical transition occurs, showing similarities with first order equilibrium transitions. For the AS model we move to a pair approximation, which reproduces the exact bulk current-density relation and consequently the location of most static transitions. Also this

model exhibits dynamical transitions, moreover two slow phases are observed when the interactions are strongly attractive. We further investigate the full dynamics of the system in the slow and fast phases, showing that the pair approximation is in good agreement with kinetic Monte Carlo simulations. We observe that the whole dynamics is independent of the control parameter in the fast phase.