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Stochastic Models for Interdisciplinary Problems

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Stochastic models based on driven diffusion have been very useful in several interdisciplinary applications, especially those related to transport and traffic problems [1]. One of the paradigmatic models for traffic flow, the Nagel-Schreckenberg model, can be viewed as a generalization of the asymmetric simple exclusion process (ASEP) which is a paradigmatic model for driven diffusion. Other generalizations have been used e.g. for crowd dynamics which describes motion in two dimensions, or intracellular transport processes where diffusion competes with Langmuir kinetics.

This presentation gives an overview over such models and their applications. The research on traffic systems shows a close interplay between empirical observations, experiments (Fig. 1, left) and theoretical investigations that rely strongly on ideas and concepts from physics. From this more theoretical perspective, universal properties of the underlying models are discussed in the presentation. Generically the models are superdiffusive and belong to the Fibonacci family [2] of dynamical universality classes which generalize the KPZ universality class [3]. Specifically, the Nagel-Schreckenberg model shows KPZ behavior (Fig.1, right) [4]. This behavior is surprisingly robust and even persists for 2-lane generalizations which are no longer single-file motion [4].

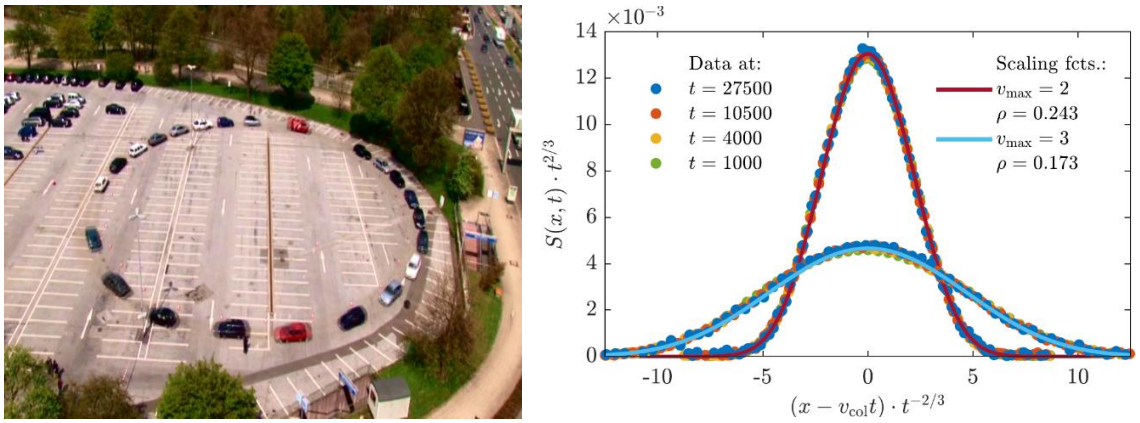

Figure 1: Left: Experiment on jam formation in vehicular traffic: Right: Dynamical structure function of the Nagel-Schreckenberg model for various model parameters.

References

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