Hybrid stochastic kinetic modelling for traffic dynamics

Mattia Zanella
Department of Mathematical Sciences *"G. L. Lagrange"*,
Politecnico di Torino

In recent years the legacy of classical kinetic theory has found fruitful applications in the mathematical description of social and life sciences. Kinetic modeling have indeed proved to provide suitable probabilistic frameworks to face the lack of fundamental principles, considering that we have at most statistical information on the underlying social forces [1, 4]. Particularly relevant is in this setting the description of traffic dynamics.

We will introduce in this talk stochastic traffic dynamics where each vehicle of the system is characterized by a 2D velocity variable, see [2]. Further, since the interaction frequencies along the road lanes are dramatically different we exploit the quasi–invariant limit technique to obtain a hybrid kinetic model for the evolution of the stochastic density of cars: a fully nonlinear Fokker–Planck equation describes the velocity along the lanes, whereas a Boltzmann–type model is given for the velocity across the lanes.

We numerically tackle the derived model taking advantage of recently introduced Structure–Preserving methods in the Uncertainty Quantification (UQ) setting [1, 3] and well–known direct Monte–Carlo methods for solving the Boltzmann step. We compare the results with real data showing the effectiveness of the model.

References

[1] G. Dimarco, L. Pareschi, M. Zanella. Uncertainty quantification for kinetic models in socio–economic and life sciences . To appear in *Uncertainty quantification for hyperbolic and kinetic equations*, S. Jin, L. Pareschi Eds, 2017.

[2] M. Herty, A. Tosin, G. Visconti, M. Zanella. Hybrid stochastic kinetic modelling for two–dimensional traffic dynamics. In preparation.

[3] L. Pareschi, M. Zanella. Structure preserving schemes for nonlinear Fokker–Planck equations and applications. *Journal of Scientific Computing*, to appear.

[4] A. Tosin, M. Zanella. Boltzmann–type models with uncertain binary interactions. Preprint `arXiv:1709.02353`, 2017.