

A MULTI-PHASE TRANSPORT MODEL FOR PEDESTRIAN MOVEMENT

STEFAN BERRES AND HARTMUT SCHWANDT

ABSTRACT. A flow composed of two populations of pedestrians moving in different directions is modeled by a two-dimensional system of convection-diffusion equations. An efficient simulation of the two-dimensional model can be obtained by a finite-volume scheme combined with a fully adaptive multiresolution strategy [4]. Numerical tests show the flow behavior in various settings of initial and boundary conditions, where different species move in countercurrent or perpendicular directions. For vanishing diffusion-terms, the equations can be characterized as hyperbolic-elliptic degenerate, with an elliptic region in the phase space, which in one space dimension is known to produce oscillation waves [2]. When the initial data are chosen inside the elliptic region, a spatial segregation of the populations leads to pattern formation. The entries of the diffusion-matrix determine the stability of the model and the shape of the patterns.

In the macroscopic multi-pedestrian flow modelled by a convection-diffusion equation, where a non-linear diffusion term describes the tactical pedestrian behavior [1]. The convection corresponds to a movement towards a strategic direction whereas the diffusion corresponds to a tactical movement that avoids jams. Different populations moving in different directions are represented by different phases. Numerical experiments demonstrate the qualitative behaviour of the simulation model.

Keywords: Crowd model; Multiphase flow; System of conservation laws.

Mathematics Subject Classifications (2000): Primary: 92D25, 35L65; Secondary: 65M50.

REFERENCES

- [1] S. Berres, G. Bärwolff, F. Huth, H. Schwandt, A multi-phase transport model for pedestrian movement, in preparation.
- [2] S. Berres, R. Bürger and A. Kozakevicius, Numerical approximation of oscillatory solutions of hyperbolic-elliptic systems of conservation laws by multiresolution schemes, *Adv. Appl. Math. Mech.*, 1, 581–614, 2009.
- [3] S. Berres, R. Ruiz-Baier, H. Schwandt and E.M. Tory, Two-dimensional models of pedestrian flow, in: Series in Contemporary Applied Mathematics (Proceedings of HYP 2010) (eds. P.G. Ciarlet and Ta-Tsien Li) Higher Education Press (Beijing) and World Scientific (Singapore) 2011, to appear.
- [4] S. Berres, R. Ruiz-Baier, H. Schwandt, E.M. Tory, An adaptive finite-volume method for a two-phase model of pedestrian flow. *Networks and Heterogeneous Media*, 6, 401–423, 2011.
- [5] J.H. Bick, G.F. Newell. A Continuum Model for Two-Directional Traffic Flow. *Quart. Appl. Math.*, 18, 191–204, 1960.

DEPARTAMENTO DE CIENCIAS MATEMÁTICAS Y FÍSICAS, FACULTAD DE INGENIERÍA, UNIVERSIDAD CATÓLICA DE TEMUCO

E-mail address: sberres@uct.cl

TECHNISCHE UNIVERSITÄT BERLIN, FAKULTÄT II, INSTITUT FÜR MATHEMATIK

E-mail address: schwandt@math.tu-berlin.de