FMSP

FMSP Lectures

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Implicit multiscale analysis of the macroscopic behaviour in microscopic models

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Abstract:

A numerical multiscale approach (equation-free analysis) is further improved in the framework of slow-fast dynamical systems and demonstrated for the example of a particle model for traffic flow. The method allows to perform numerical investigations of the macroscopic behavior of microscopically defined systems including continuation and bifurcation analysis on the coarse or macroscopic level where no explicit equations are available. This approach fills a gap in the analysis of many complex real-world applications including particle models with intermediate number of particles where the microscopic system is too large for a direct numerical analysis of the full system and too small to justify large-particle limits.

An implicit equation-free method is presented which reduces numerical errors of the equation-free analysis considerably. It can be shown that the implicitly defined coarse-level time stepper converges to the true dynamics on the slow manifold. The method is applied to perform a coarse bifurcation analysis of microscopic particle models describing car traffic on single lane highways. The results include an equation-free continuation of traveling wave solutions, identification of bifurcations as well as two-parameter continuations of bifurcation points. This is joint work with Christian Marschler and Jan Sieber.