McMaster University | University of Toronto | University of Waterloo

THE FIELDS INSTITUTE FOR RESEARCH IN MATHEMATICAL SCIENCES

Short Course on Lattice Gas Automata Methods

Lecture 1: Lattice-Gas Automata for Hydrodynamics

Karen Diemer, The Fields Institute for Resaerch in Mathematical Sciences
Thursday June 03, 1993: 10:00 - 11:00, 11:30 - 12:30

The lecture will begin with a description of the simplest lattice gas automata for hydrodynamics. Kinetic equations for microscopic particle distributions will be constructed. Then hydrodynamic equations will be derived using the Chapman-Enskog expansion. Discussion of the limitations on the parameter range for which the lattice gas automaton method is valid will follow. Comparison of lattice gas automata results with analytical predictions, physical experiments and finite difference methods will be reviewed.

Lecture 2: Lattice Gas Automata for Chemically Reacting Systems: Theory

Anna T. Lawniczak, University of Guelph/ The Fields Institute for Resaerch in Mathematical Sciences
Thursday June 03, 1993: 2:00 - 3:00 pm, 3:30 - 4:30 pm

A multispecies reactive lattice-gas automaton model for reaction-diffusion system will be constructed. Microdynamical equations for the evolution of the system will be derived; the discrete and continuous Boltzmann equations will be developed and their reduction to reaction-diffusion equations will be discussed. Also, we will discuss the determination of reaction probability matrices and space and time scaling. As an explicit example of the general formalism a lattice gas automaton for the Selkov model will be constructed and it's spatio-temporal dynamics discussed.

Lecture 3: Reactive Lattice-Gas Automata: Applications

Xiao-Guang Wu, University of Toronto
Friday June 04, 1993: 10:00 - 11:00 am

Applications of lattice-gas automaton method to two chemically reacting systems will be discussed.

1. A lattice-gas automaton model for CO oxidation on metal surfaces is developed and applied to study the reactive dynamics of the system.
2. The effects of internal noise on chaotic and periodic dynamics of the WR (Willamowski-Rössler) reaction are investigated. The character of the noisy dynamics is analysed and questions related to the validity of deterministic models in the chaotic regime are discussed.

Lecture 4: Lattice Boltzmann Computational Fluid Dynamics

Shiyi Chen, Los Alamos National Laboratory
Friday June 04, 1993: 11:30 - 12:30 pm, 2:00 - 3:00 pm, 3:30 - 4:30 pm

In this talk, we will discuss the basic principle of lattice Boltzmann method, its mathematical background and the numerical stability analysis. A close comparison of the lattice Boltzmann method with the lattice gas technique and other traditional numerical schemes, including the finite difference scheme and the pseudo-spectral method, will be given. Recent achivements of the lattice Boltzmann method and its applications to several interesting physical systems will be presented, including high Reynolds number turbulent flows, multiphase dynamics, heat transfer and polymeric physics.

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