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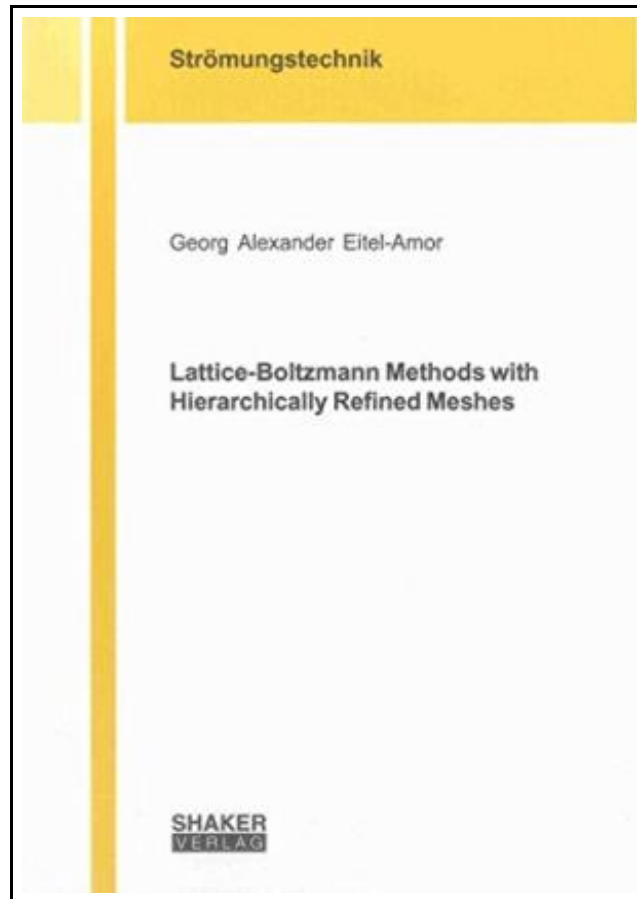
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LATTICE-BOLTZMANN METHODS WITH HIERARCHICALLY REFINED MESHES

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Shaker Verlag Nov 2012, 2012. Buch. Book Condition: Neu. 214x149x17 mm. Neuware - Since its initiation in the late 1980s, the lattice-Boltzmann method (LBM) has emerged as an eminent tool for numerical investigations of fluid flows involving complex physics and highly intricate geometries. Compared to conventional approaches, which utilize a discretization of the Navier-Stokes equations, the LB method offers a simple algorithmic structure, very good parallel scale-up, and an efficient boundary treatment for fixed walls. However, the method is still subject to ongoing research and development concerning its complex stability behavior and the use of non-uniform meshes. The purpose of this work is to explore possible improvements and new applications for LBM by developing a highly productive parallel LB flow solver based on hierarchically refined Cartesian meshes. The numerical method and the developed techniques for local grid refinement, solution-adaptation, and large-eddy simulations (LES) are described in detail. To validate the implemented methods, two-dimensional and threedimensional laminar and turbulent flows over blunt bodies at Reynolds numbers up to ReD = 3700 are simulated and adaptive mesh refinement is successfully applied in simulations of steady and unsteady cylinder flow. The results evidence a very good agreement with reference values from the literature regarding the velocity field, the wall-pressure distribution, and the coefficients for drag, lift and vortex-shedding frequency. Additionally, the LBM is successfully applied for a direct numerical simulation (DNS) and a LES study of a temporally evolving shear layer. It is shown that the LES approach delivers reliable results for turbulent flows proving the applicability of LBM for practical engineering applications. In an additional investigation, the classical Bhatnagar-Gross-Krook (BGK) collision operator is compared to moment-based methods in studies of laminar and turbulent wall-bounded flows with respect to stability and accuracy. All methods are found to deliver consistent results, whereas the LBGK...

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