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Entropic Lattice Boltzmann Methods for Fluid Mechanics: Thermal, Multi-phase and Turbulence SHYAM CHIKATAMARLA, F. BOESCH, N. FRAPOLLI, A. MAZLOOMI, I. KARLIN, ETH Zurich — With its roots in statistical mechanics and kinetic theory, the lattice Boltzmann method (LBM) is a paradigm-changing innovation, offering for the first time an intrinsically parallel CFD algorithm. Over the past two decades, LBM has achieved numerous results in the field of CFD and is now in a position to challenge state-of-the art CFD techniques [1]. Major restyling of LBM resulted in an unconditionally stable entropic LBM which restored Second Law (Boltzmann H theorem) in the LBM kinetics and thus enabled affordable direct simulations of fluid turbulence [2, 3]. In this talk, we shall review recent advances in ELBM as a practical, modeling-free tool for simulation of complex flow phenomenon. We shall present recent simulations of fluid turbulence including turbulent channel flow, flow past a circular cylinder, creation and dynamics of vortex tubes, and flow past a surface mounted cube. Apart from its achievements in turbulent flow simulations, ELBM has also presented us the opportunity to extend lattice Boltzmann method to higher order lattices which shall be employed for turbulent, multi-phase and thermal flow simulations. A new class of entropy functions are proposed to handle non-ideal equation of state and surface tension terms in multi-phase flows. It is shown the entropy principle brings unconditional stability and thermodynamic consistency to all the three flow regimes considered here. Acknowledgements: ERC Advanced Grant "ELBM" and CSCS grant s437 are deeply acknowledged. References: [1] Chikatamarla et al, J.Fluid.Mech, 656 (2010); Physica.A,392(2013) [2] Chikatamarla and Karlin, Phys.Rev.Lett., 010201 (2006); Phys.Rev.Lett, 190601 (2006). [3] Karlin et al, Europhys. Letters, 47, no. 2, p. 182, 1999.

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