Novel Kinetic Consistent Algorithm for the modelling of incompressible conducting flows

B. Chetverushkin[†], N. D'Ascenzo*, A. Saveliev[††] and V. Saveliev[†††]

[†]Institute of Applied Mathematics
Russian Academy of Sciences
Miusskay sq. 4, 124047, Moscow, Russia
office@kiam.ru, web page: http://www.kiam.ru

*DESY
Notkestrasse 85, 22607-, Hamburg, Germany
ndasc@mail.desy.de, web page: http://www.desy.de

[††]Hamburg University
Notkestrasse 85, 22607, Hamburg, Germany
asavelie@mail.desy.de, web page: http://www.uni-hamburg.de

[†††]Immanuel Kant Baltic Federal University
Al. Nevskogo 14a, 236041, Kaliningrad, Russia
saveliev@mail.desy.de, web page: http://www.kantiana.ru

ABSTRACT

A perspective modern direction in computational fluid dynamics (CFD) is the development of kinetic and kinetic consistent models and algorithms, which were successfully used for a number of applied problems such as direct turbulence problems, non persistent flows, flammable flows, aero acoustics and aeroelasticity [1]. The basis of kinetic consistent algorithms consists of explicit schemes, which are logically simple and allow an effective adaptation to modern architectures of high performance computing systems with massive parallelism.

In this study we aim at demonstrating that kinetic consistent algorithms are a valid model for the computation of the dynamics of incompressible flows. We obtain numerical solutions for standard test problems, namely the laminar flow inside a wall-driven cavity, laminar flow over a backward-facing step and turbulent flow over a backward-facing step. We show that kinetic consistent algorithms have a high stability in the solution of convection-dominated flows, due to a correct physical modeling of the fluid viscosity and to the possibility of tuning appropriate regularization terms on the basis of the physical properties of the fluid.

A further object of study is the extension of the above-mentioned kinetic consistent gas dynamics algorithms to the magneto hydrodynamics modeling, in particular to the modeling of incompressible conducting fluids [2]. We show that the kinetic consistent approach offers a stable basis for a correct physical description of the shear viscosity, thermal conduction and electric resistivity effects in incompressible magneto hydrodynamics flows.

REFERENCES

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