The 18th International Conference on Finite Elements in Flow Problems (FEF2015)
16-18 March 2015, Taipei, Taiwan

A review of residual distribution methods for compressible fluid dynamics

R. Abgrall (1) and D. de Santis (2)

[1] Institute of mathematics, University of Zurich, Switzerland
remi.abgrall@math.uzh.ch
calin@pme.nthu.edu.tw
[2] Department of Mechanical Engineering,
Stanford University
ddesanti@stanford.edu

Key Words: *Compressible flows, residual distribution methods, high order schemes*

In this talk, I will review the current status of the so-called residual distribution schemes applied, in particular, to compressible fluid dynamics problems. Other physical models include the Shallow Water equation and generalization, MHD, etc
This schemes, after the early work of R. Ni at Bombardier, and the seminal work of P.L Roe, in particular his 1981 JCP paper and its extensions to scalar multidimensional schemes, can be considered as finite element methods of the streamline diffusion type. The emphasis is put in non-oscillatory properties, in order to be able to compute flow discontinuities, so that they are non linear by construction. Indeed shock capturing is done in a totally different manner as for stream line diffusion, allowing for a class of parameter free schemes. In a way, the Residual Distribution methods can be seen as a kind of compromise between high order TVD-like finite difference/finite volume schemes and classical finite element methods, in that they borrow ideas from both communities : geometrical flexibility, the residual concept on one side, and non oscillatory, maximum principle on the other one.
In the talk, we will first consider the case of steady scalar hyperbolic problems, showing how one can systematically construct parameter free essentially non-oscillatory schemes. Then we will move towards steady advection diffusion problems, showing how uniform accuracy, whatever the Peclet/Reynolds number is. The last part of the talk will consider recent work on unsteady problems. Examples of compressible flows (laminar and turbulent) will be also shown, in order to demonstrate the efficiency of the method, both in accuracy, memory foot print and CPU time.

REFERENCES

[1] R. Abgrall and D. de Santis, High-order preserving residual distribution schemes for advection-diffusion scalar problems on arbitrary grids, SIAM J. Scientific Computing, in press, 2014
[2] R. Abgrall and Dante de Santis, Linear and non-linear high order accurate residual distribution schemes for the discretization of the steady compressible Navier-Stokes equations, Journal of Computational Physics, in revsion, 2014.