HIGHER ORDER BOUNDARY CONDITIONS AND CURVED BOUNDARY REPRESENTATION FOR RESIDUAL DISTRIBUTION SCHEMES

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The background of this project are third and fourth order multidimensional upwind discretizations based on the concept of 'fluctuation splitting', known also as residual distribution schemes (*RDS*), developed in the PhD of Nadège Villedieu. as part of the European FPG project ADIGMA.

When higher–order schemes are used, it is important to discretize the boundary conditions with sufficient order of accuracy, or else unphysical phenomena may negatively influence the solution. The geometrical boundary representation itself needs to be of higher order (e.g. described by parabolic or cubic polynomial).

Inviscid flow around an airfoil may be considered as an example. The discretized surface of the airfoil consists of straight edges, and additional entropy is generated at the leading edge where the grid lines form a wedge. This entropy is then transported along the surface of the airfoil and spoils numerical solution.

The aim of the project was to develop higher–order geometry discretization for curved boundaries (parabolic or cubic) and implement higher–order flux boundary integration for RDS on curvilinear elements. The implementation was done in the RDS solver within the COOLFluiD environment.

One possible approach has been implemented for isoparametric Lagrangian triangles whose geometry is defined by quadratic polynomials. The method was tested for both scalar problems and the system of steady Euler equations. We show 3rd order accuracy and significant decrease of entropy losses when higher order geometry representation is used on meshes with the same number of degrees of freedom representing the solution.

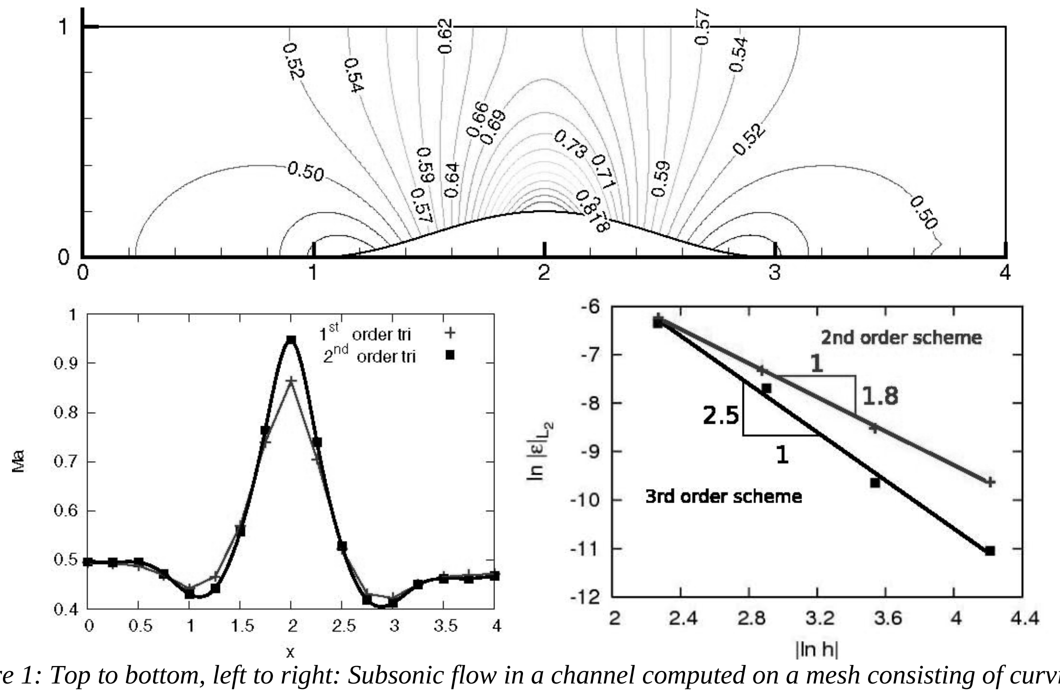

Figure 1: Top to bottom, left to right: Subsonic flow in a channel computed on a mesh consisting of curvilinear triangles, comparison of Mach number distribution on the bottom wall of the channel (LDA scheme on a coarse mesh with first order linear and second order curved elements) and convergence comparison