

Report on the Dissertation Thesis

Jaroslava Hasnedlová: "Fluid-Structure Interaction of Compressible Flow"

Translation of the report written by Prof. Dr. Michal Křížek, DrSc.

The submitted dissertation thesis is concerned with numerical solution of a nonlinear evolution partial differential equation with the aid of the discontinuous Galerkin method. This subject definitely belongs among topical problems of contemporary numerical and computational mathematics.

The thesis is divided in 13 chapters. First four chapters are devoted to the analysis of the discontinuous Galerkin method for nonlinear problems of convection-diffusion. Further chapters are concerned with the problem of interaction of compressible viscous flow with an elastic body, which is discretized with the aid of the finite element method and the Newmark method.

The main results of the thesis are according my opinion contained in Chapters 3 and 4. Here a number of auxiliary assertions are formulated, related to upper (or lower) estimates of investigated functions in several different norms. These are then applied to the estimation of the discretization error in terms of the time step τ and the discretization parameter h . As original, I consider particularly Theorems 4.7 and 4.9 and their proofs.

Reading the dissertation, I found several misprints and graphical errors. For example, on page 14, line 8, the unit normal is written bold, whereas in Figure 2.1 it is written in a normal form with an arrow. Moreover, these unit normals have different lengths in the figure. In Figure 2.1., for completeness, it would be suitable to mark also normals to three outer sides on the right. On line 12, K should be written in italics: $\text{diam}(K)$. Also further quantities should be written in italics: $\max_{K \in \mathcal{T}_{h,m}} h_K$ and $\max_{m=1, \dots, M} h_m$. On line 14, it is written: $K.d(\Gamma)$, which looks a a multiplication. It could be written as: The symbol $d(\Gamma)$ denotes ... (see also line 4). On line 15 it should be written $\max_{m=1, \dots, M} \tau_m$. On line 18, it should be written "Then we denote" instead of "Than we denote". The limit on line 19 need not exist, if the function φ is, for example, a non-measurable function. I would welcome, if during the defence, the author would precisely formulate some sufficient conditions guaranteeing the existence of this limit. On line 24, in the right-hand side of relation (2.3), there is one more left parenthesis (.).

I would like to draw the author's attention to several further inconsistencies, which can be easily corrected. Physical units should be written as roman letters - see, e.g., page 3, line 7. On page 4, it is suitable to separate

the numbering of figures from the description of figures by a blank space. A polyhedral domain Ω on page 11 need not have a Lipschitz-continuous boundary, for which some results are used. In Lemma 3.4 on page 23, it would be suitable to remind that $J_{h,m}$ is defined by relation (2.16) and on the third line one symbol = should be omitted. On page 131 the reference [53] is not introduced according to the alphabet.

On page 99 a table of seven-point numerical integration with rounded-off values is introduced. However, the corresponding weights are not algebraic numbers. They can be written with the aid of square roots $\omega = (155 \pm \sqrt{15})/1200$. It is also better to write the components of integration points with the aid of square roots $(9 \pm 2\sqrt{15})/21$ and $(6 \pm \sqrt{15})/21$, similarly in Table 11.1 on page 98.

Further, I would welcome, if J. Hasnedlová could briefly mention difficulties with the numerical solution of three-dimensional problems.

It is necessary to emphasize that the subject of the dissertation was very difficult. The presented proofs and numerical processes are elegant. They certainly required a lot of effort, mathematical erudition and good ideas. This is also true for numerical tests introduced in Chapters 12 and 13. The submitted dissertation thesis is a nice contribution to the numerical solution of nonlinear evolution partial differential equations. In the year 2011, J. Hasnedlová already published (with co-authors) a paper devoted to the investigated subject in the prestigious journal *Numerische Mathematik*.

Therefore, I warmly recommend to evaluate the dissertation thesis by the grade 1.5 and to award Jaroslava Hasnedlová the title Ph.D.

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