

Report of the supervisor

on the PhD Thesis of **Jan Papež** with the title

Algebraic Error in Matrix Computations in the Context of Numerical Solution of Partial Differential Equations

I know Jan Papež since his undergraduate studies. He finished his Bc and Mgr degrees at Charles University, and he has also prepared the presented PhD Thesis under my supervision, complemented also by the guidance by Prof. Martin Vohralík. The Spring semester 2013 Jan spent within the Erasmus Programme at the Jacques-Louis Lions Laboratory, Université Pierre et Marie Curie (Paris 6), where the collaboration with Prof. Martin Vohralík, presently at INRIA Paris, has started.

Jan Papež has a very solid background in a wide area of mathematics, including classical calculus, algebra, functional analysis, differential equations, numerical analysis, computational methods and their implementations. He benefited from this background in the work on the PhD Thesis that focuses on various aspects of incorporating the algebraic error and its analysis into the adaptive numerical solution of partial differential equations. The topic of the Thesis required investigating interconnections between different views, leaving the commonly used paths and footsteps, giving a second thought to commonly accepted views, and exploring new possibilities and adventures. Such approach has certainly been demanding on the candidate.

As a consequence, the results presented in the Thesis formally belong into two groups. Results in the first group were submitted for publication in the form of the journal manuscripts. One of them has already been published (Linear Algebra and Its Applications, 2014). Two manuscripts have been submitted for publication (IMA Journal on Numerical Analysis, Numerische Mathematik, both May 2016). The first of them has in the meantime been revised (December 2016). All three papers revisit existing approaches and challenge some widely accepted opinions (distribution of the discretization and algebraic error over the solution domain, construction and computational cost of mathematically rigorously justified stopping criteria for algebraic iterative solvers in numerical PDEs, revisiting and interpreting the residual-based error bounds in the presence of inaccurate algebraic computations etc.). The role of the candidate in the work on and on preparation of the manuscripts has been very substantial (this is also reflected by the order of the authors in the first of them that is not alphabetical). The papers also formulate open questions that are, in my opinion, important for the whole field. The results in the second group has not yet been written up as manuscripts. This does not mean that they are of negligible value. The associated questions are difficult and more work is needed in order to get the material suitable for stand-alone publications in one of the top journals. Within the Thesis these results serve nicely in showing that the problem of incorporating inexact algebraic computation into numerical PDEs,

which must be done with no alternative in large scale computations, has many sides, where some of them have barely been opened worldwide.

Jan Papež belongs among the best students I have had an opportunity to work with. He is motivated, thorough and persistent. While working on the Thesis, he has matured into a valuable and reliable scientific partner with an independent area of expertise. His independence can also be demonstrated by numerous interactions with the PhD students, postdocs and researchers at home and abroad, which is well documented in the Thesis, as well as by active participation at top international meetings and schools (such as, e.g., Gene Golub Summer School 2013).

Jan Papež is also a very pleasant person to deal with. He is always ready to help to others and he has therefore played a very positive role in the students community, e.g., through his involvement in the Charles University Student Chapter of SIAM, where he served for three years as the President. I consider this very important, because personal maturity proved by a valuable service to others is, in my opinion, also a matter of the time of graduate studies and it creates a foundation for a fruitful professional career as well as personal life in the future.

I recommend with a pleasure this PhD Thesis to the defence. I am convinced that it demonstrates the scientific as well as personal quality of the candidate and indicates very positive prospects for his possible future academic (or non-academic) career.

Prague, January 31, 2017

Zdeněk Strakoš