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Faculty of Civil Engineering
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Opponent's review of the Doctoral Thesis

Candidate Martin Ladecký

Title of the doctoral thesis Advanced spectral methods for computational homogenization of periodic media

Study Programme Mathematics in Civil Engineering

Tutor Ivana Pultarová

Opponent Matti Schneider

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Topicality of the doctoral thesis theme				
Commentary: The thesis is concerned with computational homogenization methods on regular grids, addressing matters concerned with reducing the impending computational effort. In addition to preconditioning strategies, modern low-rank approximations are considered.				
☒ excellent	☐ above average	☐ average	☐ below average	☐ poor

Fulfilment of the doctoral thesis objectives				
Commentary: The ambitious objectives have been fulfilled by the candidate, asexemplified by the five topical publications in high-rank journals with quality control.				
☒ excellent	☐ above average	☐ average	☐ below average	☐ poor

Research methods and procedures				
Commentary: The candidate has masterfully combined methods of modern mathematics to quite applied questions of computational multiscale mechanics.				
☒ excellent	☐ above average	☐ average	☐ below average	☐ poor

Results of the doctoral thesis – dissertant's concrete achievements				
Commentary: The candidate has provided a coherent contribution to computational homogenization methods based on the fast Fourier transform by working out preconditioning strategies for finite-element based discretizations on a regular grid. Moreover, transferring the ideas to low-rank tensor approximations is rather innovative. All in all, the range of topics covered at depth is rather remarkable, and is demonstrated by five high-level journal publications.				
☒ excellent	☐ above average	☐ average	☐ below average	☐ poor

Importance for practice and for development within a branch of science

Commentary: The candidate worked on removing the formal barrier between methods based on the fast Fourier transform (FFT) and classical finite-element (FE) discretizations. In particular, I expect that it will be possible to transfer ideas from the FE community to the FFT-based computational homogenization community. In particular, the results reported in the thesis appear to be only the tip of the iceberg, and the candidate may work out further connections in the near future.

☒ excellent	☐ above average	☐ average	☐ below average	☐ poor

Formal layout of the doctoral thesis and the level of language used

Commentary: The layout and organization are coherent as well as natural. The level of language is appropriate for a high-level scientific work.

☒ excellent	☐ above average	☐ average	☐ below average	☐ poor

Statement on compliance with citation ethics

I have no objections.

Remarks

None.

Final assessment of the doctoral thesis

Martin Ladecký made fundamental contributions to computational homogenization methods on regular grids by clarifying the relation of the spectrum of the preconditioned operators to the underlying material properties and transferring this knowledge to modern computational methods based on both the fast Fourier transform and low-rank tensor approximations. The work contains a number of novelties, and it is a pleasure to read.

Following a successful defence of the doctoral thesis I recommend the granting of the Ph.D. degree

yes ☒	***no*** ☐

Date: 22.08.2022

Opponent's signature:.....