Jakub Šístek

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Contact information

Institute of Mathematics
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Date of birth June 21, 1981 in Tábor (Czech Republic)

Family married to Hana Šístková since 2006
daughter Anežka Šístková (2007), sons Radim Šístek (2010) and Rostislav Šístek (2012)

Research interests

Numerical Mathematics: numerical solution of partial differential equations, domain decomposition methods, finite element method, uncertainty quantification.

Computational Fluid Dynamics: incompressible viscous flow simulations, vortex identification methods, parellel solvers for CFD, stabilization of the finite element method.

Programming: high-performance computing, MPI, GPU computing.

Education

PhD (2008) Czech Technical University in Prague (Czech Republic)
Faculty of Mechanical Engineering, Department of Mathematics
Dissertation title: *The finite element method in fluids: stabilization and domain decomposition*, advisor Pavel Burda

Ing (MSc equivalent) (2005) Czech Technical University in Prague (Czech Republic)
Faculty of Mechanical Engineering, Department of Mathematics, with *summa cum laude*
Thesis title: *Stabilization of finite element method for solving incompressible viscous flows*, advisor Pavel Burda

Honours

Otto Wichterle Premium 2013
(awarded annually by *the Czech Academy of Sciences* to promising young researchers)

Professor Babuška Prize for an important contribution to computer science 2009
(awarded jointly by *the Union of Czech Mathematicians and Physicists*
and *the Czech Society for Mechanics* for the best doctoral dissertation of the year)

Professor Zvoníček foundation award 2009
(awarded by the Faculty of Mechanical Engineering, Czech Technical University in Prague
for the best doctoral dissertation in theoretical disciplines of the year)

Professor Babuška Honour for Master thesis 2005
(awarded jointly by *the Union of Czech Mathematicians and Physicists*
and *the Czech Society for Mechanics* for selected Master theses of the year)

Karel Spála Prize 2005
(awarded by the Faculty of Mechanical Engineering, Czech Technical University in Prague
for the best Master thesis in theoretical disciplines of the year)

Employment

Institute of Mathematics of the Czech Academy of Sciences, Prague
Research Fellow at the Department of Numerical Analysis Jan 2013–present
Postdoctoral Fellow at the Department of Numerical Analysis Jan 2009–Dec 2012

University of Cambridge, Department of Engineering (United Kingdom)
Research Associate Mar–Jul 2011, Dec 2011–Jan 2012

University of Colorado Denver, Dept. of Mathematical & Statistical Sciences (USA)
Research Assistant Sep–Dec 2007, Feb–May 2009

Aeronautical Research and Test Institute, Prague
Research Assistant at the Dept. of Low Speed Aerodynamics (part-time) 2006–2009

Czech Technical University in Prague, Faculty of Mechanical Engineering
Teaching Assistant at the Department of Mathematics (part-time) 2003–2014

Research visits

University of Colorado Denver, Dept. of Mathematical & Statistical Sciences (USA)
Visiting Researcher (with Prof Mandel) Sep–Oct 2012, Mar–May 2013, Feb 2014
Research Assistant (with Prof Mandel) Sep–Dec 2007, Feb–May 2009

University of Cambridge, Department of Engineering (United Kingdom)
Research Associate (with Dr Cirak) Mar–Jul 2011, Dec 2011–Jan 2012

CINECA Supercomputing Centre, Bologna (Italy)
Visiting Researcher (within HPC Europa 2 project) Sep–Nov 2010

Edinburgh Parallel Computing Centre (United Kingdom)
Visiting Researcher (within HPC Europa project) Sep–Dec 2005

Teaching experience

University of West Bohemia, Pilsen, Czech Republic 2015–
Faculty of Applied Sciences, Department of Mathematics
Courses: *Domain Decomposition Methods*

Czech Technical University in Prague, Czech Republic 2006–2014
Faculty of Mechanical Engineering, Department of Mathematics
Courses: *Calculus*, *Numerical Analysis*, *Algorithmization and Programming*

Invited seminar lectures

Los Alamos National Laboratory (2014), *Stanford University* (2013), *University of Colorado Denver* (2007, 2009, 2012, 2014), *Charles University, Prague* (2013, 2014), *University of West Bohemia Pilsen* (2012), *Technische Universität Dresden* (2011), *VŠB–Technical University of Ostrava* (2011, 2014)

Presentations at international conferences

IMA Conference on Numerical Methods for Simulation (Oxford, UK, 2015), *DD23* (Jeju Island, Korea, 2015), *HPCSE 2015* (Beskydy, Czech Republic, 2015), *Topical Problems of Fluid Mechanics 2015* (Prague, Czech Republic, 2015), *SNA 2015* (Ostrava, Czech Republic, 2015, **invited lecture**), *WCCM - ECCM - ECFD 2014* (Barcelona, Spain, 2014), *PMAA 2014* (Lugano, Switzerland, 2014), *ESCO 2014* (Pilsen, Czech Republic), *Modelling 2014* (Rožnov pod Radhoštěm, Czech Republic), *SPOMECH Workshop* (Ostrava, Czech Republic, 2013, **invited lecture**), *PIM 2013* (Prague, Czech Republic), *HPCSE 2013* (Beskydy, Czech Republic), *SPOMECH Autumn School* (Ostrava, Czech Republic, 2012, **invited lecture**), *PANM 16* (Dolní Maxov, Czech Republic, 2012, **invited lecture**), *ESCO 2012* (Pilsen, Czech Republic), *Applications of Mathematics 2012* (Prague, Czech Republic), *ENUMATH 2011* (Leicester, UK), *ICCFD 6* (St Petersburg, Russia, 2010), *MAFELAP 2009* (London, UK), *ParCFD 2009* (Moffet Field, California, USA), *SUPERCONVERGENCE 2008* (Prague, Czech Republic), *MAFELAP 2006* (London, UK), *FEF05* (Swansea, UK, 2005)

Participation in international research projects

HIGHERFLY, Immersed methods for insect flight aerodynamics, coordinator: University of Cambridge, role: coinvestigator, awarded by PRACE infrastructure under DECI programme May 2013–Jul 2014

HIFLY, Direct numerical simulation of flows occurring in insect flight, coordinator: University of Cambridge, role: coinvestigator, awarded by PRACE infrastructure under DECI programme Nov 2011–Oct 2012

EP/G008531/1, Computational Toolbox for Fluid-Membrane Interaction with Applications to Micro Air Vehicles and Insect Flight, coordinator: University of Cambridge, role: team member, awarded by EPSRC 2009–2012

DMS-0713876, Adaptive Multilevel Iterative Substructuring Methods, coordinator: University of Colorado Denver, role: team member, awarded by NSF 2007–2010

Participation in national research projects

GAČR 14-02067S, Advanced methods for flow-field analysis, coordinator: Institute of Hydrodynamics of AS CR, role: principal coinvestigator, awarded by Czech Science Foundation 2014–2016

Domain Decomposition Solvers for Incompressible Flows, coordinator: Institute of Mathematics of AS CR, role: principal investigator, awarded by IT4Innovations Jan–Sep 2015

Scalable Solvers for Subsurface Flow Simulations, coordinator: Institute of Mathematics of AS CR, role: principal investigator, awarded by IT4Innovations Jun–Dec 2013

LH11004, Domain Decomposition Methods, coordinator: Czech Technical University in Prague, role: team member, awarded by AMVIS–MŠMT 2011–2014

Service for the community

Scientific committees of *European School on Mathematical Modelling, Numerical Analysis and Scientific Computing at Kácov (2016)*, *High Performance Computing in Science and Engineering HPCSE (2015)*.

Organizing committees of *Programs and Algorithms of Numerical Mathematics PANM 17 (2014), PANM 16 (2012), PANM 15 (2010)*, *Applications of Mathematics (2015, 2013, 2012)*, *EQUADIFF 2013*.

Minisymposium organiser at *DD23 (2015)*, *MAFELAP 2011*.

Editor of conference proceedings *HPCSE 2015*, *PANM (2014, 2012, 2010)*, *Applications of Mathematics (2015, 2013, 2012)*.

Coorganiser of a weekly seminar *Current Problems in Numerical Analysis* (Institute of Mathematics of AS CR) since 2013.

External expert of PRACE research infrastructure for evaluating applications for computing time on the largest European (Tier-0) supercomputers (reviewer, panel member) since 2013.

Reviewer for *International Journal for Numerical Methods in Fluids*, *Mathematics and Computers in Simulation*, *Applications of Mathematics*, *Applied Mathematics and Computation*, *Engineering with Computers*, *Czechoslovak Mathematical Journal*.

Leading of students (Czech Technical University in Prague): 2 Bc students (2012, expected 2015), 1 MSc student (2014), 1 PhD student (since 2014).

Mentor in the *AMathNet* project for knowledge transfer within applied mathematics
one week student interships in the Institute of Mathematics of AS CR (2013, 2014).

Science popularisation talk *Simulations, Supercomputers, ... and Mathematics* during the *Week of Science and Technology* (2014, 2013) and during Open Doors Day of the Institute of Mathematics of AS CR (2014, 2013).

Society membership

EU-MATHS-IN.CZ — Czech Network for Mathematics in Industry
member 2014–
treasurer (elected for 1 year) 2015–

Union of Czech Mathematicians and Physicists (JČMF) through the Czech Mathematical Society
member 2009–

Software

BDDCML An open-source massively parallel library for solving large systems of equations with sparse matrices by the *Adaptive-Multilevel BDDC method*. Written in Fortran 95 with MPI. Tested on up to 65 thousand processor cores. About 10 external users. 2007–present

Vortex Analysis Library (VALIB) A collection of routines for vortex identification and vizualization based on region-type methods. Written in C, CUDA and OpenCL. To be published as open-source software by 2016. 2009–present

Citations

58 (h-index 5) according to *Web of Science*, 62 (h-index 5) according to *Scopus*, and over 200 (h-index 9) according to *Google Scholar*.

Publications

Peer-reviewed journals

1. Šístek, J., Březina, J., and Sousedík, B. BDDC for mixed-hybrid formulation of flow in porous media with combined mesh dimensions. *Numer. Linear Algebra Appl. 22*, 6 (2015), 903–929.
2. Šístek, J., and Cirak, F. Parallel iterative solution of the incompressible Navier-Stokes equations with application to rotating wings. *Comput. & Fluids 122* (2015), 165–183.
3. Kolář, V., and Šístek, J. Corotational and compressibility aspects leading to a modification of the vortex-identification Q-criterion. *AIAA Journal 53*, 8 (2015), 2406–2410.
4. Kolář, V., Šístek, J., Cirak, F., and Moses, P. Average corotation of line segments near a point and vortex identification. *AIAA Journal 51*, 11 (2013), 2678–2694.
5. Sousedík, B., Šístek, J., and Mandel, J. Adaptive-Multilevel BDDC and its parallel implementation. *Computing 95*, 12 (2013), 1087–1119.
6. Šístek, J., Čertíková, M., Burda, P., and Novotný, J. Face-based selection of corners in 3D substructuring. *Math. Comput. Simulation 82*, 10 (2012), 1799–1811.
7. Mandel, J., Sousedík, B., and Šístek, J. Adaptive BDDC in three dimensions. *Math. Comput. Simulation 82*, 10 (2012), 1812–1831.

8. Šístek, J., Sousedík, B., Burda, P., Mandel, J., and Novotný, J. Application of the parallel BDDC preconditioner to the Stokes flow. *Comput. & Fluids 46* (2011), 429–435.
9. Hájek, J., Szöllös, A., and Šístek, J. A new mechanism for maintaining diversity of Pareto archive in multiobjective optimization. *Adv. Eng. Softw. 41*, 7–8 (2010), 1031–1057.
10. Šístek, J., Novotný, J., Mandel, J., Čertíková, M., and Burda, P. BDDC by a frontal solver and stress computation in a hip joint replacement. *Math. Comput. Simulation 80*, 6 (2010), 1310–1323.
11. Burda, P., Novotný, J., and Šístek, J. Accuracy of semiGLS stabilization of FEM for solving Navier–Stokes equations and a posteriori error estimates. *Internat. J. Numer. Methods Fluids 56*, 8 (2008), 1167–1173.
12. Burda, P., Novotný, J., and Šístek, J. Numerical solution of flow problems by stabilized finite element method and verification of its accuracy using a posteriori error estimates. *Math. Comput. Simulation 76*, 1–3 (2007), 28–33.
13. Burda, P., Novotný, J., and Šístek, J. Finite element solution of Navier-Stokes equations adapted to a priori error estimates. *WSEAS Trans. Math. 5*, 1 (2006), 188–195.
14. Burda, P., Novotný, J., and Šístek, J. On a modification of GLS stabilized FEM for solving incompressible viscous flows. *Internat. J. Numer. Methods Fluids 51*, 9–10 (2006), 1001–1016.
15. Burda, P., Novotný, J., and Šístek, J. Precise FEM solution of a corner singularity using an adjusted mesh. *Internat. J. Numer. Methods Fluids 47*, 10–11 (2005), 1285–1292.

Peer-reviewed conference proceedings

1. Šístek, J. A parallel finite element solver for unsteady incompressible Navier-Stokes equations. In *Proceedings of Topical Problems of Fluid Mechanics 2015, Prague, Czech Republic, February 11–13, 2015*, D. Šimurda and T. Bodnár, Eds. Institute of Thermomechanics AS CR, 2015, pp. 193–198.
2. Hanek, M., Šístek, J., and Burda, P. An application of the BDDC method to the Navier-Stokes equations in 3-D cavity. In *Proceedings of Programs and Algorithms of Numerical Mathematics 17, Dolní Maxov, Czech Republic, June 8–13, 2014*, J. Chleboun, P. Přikryl, K. Segeth, J. Šístek, and T. Vejchodský, Eds. Institute of Mathematics AS CR, 2015, pp. 77–85.
3. Čertíková, M., Šístek, J., and Burda, P. Different approaches to interface weights in the BDDC method in 3D. In *Proceedings of Programs and Algorithms of Numerical Mathematics 17, Dolní Maxov, Czech Republic, June 8–13, 2014*, J. Chleboun, P. Přikryl, K. Segeth, J. Šístek, and T. Vejchodský, Eds. Institute of Mathematics AS CR, 2015, pp. 47–57.
4. Kolář, V., and Šístek, J. Recent progress in explicit shear-eliminating vortex identification. In *Proceedings of 19th Australasian Fluid Mechanics Conference, Melbourne, Australia, December 8–11, 2014*, H. Chowdhury and F. Alam, Eds. RMIT University, 2014. Article no. 274.
5. Šístek, J., Mandel, J., Sousedík, B., and Burda, P. Parallel implementation of Multilevel BDDC. In *Numerical Mathematics and Advanced Applications 2011 (Proceedings of ENUMATH 2011)*, A. Cangiani et al., Eds. Springer, 2013, pp. 681–689.
6. Šístek, J., Kolář, V., Cirak, F., and Moses, P. Fluid-Structure Interaction and Vortex Identification. In *Proceedings of the Eighteenth AUSTRALASIAN FLUID MECHANICS CONFERENCE*, Brandner, P.A. and Pearce, B.W., Eds. Australasian Fluid Mechanics Society 2012. Paper no. 125.
7. Šístek, J., Mandel, J., and Sousedík, B. Some practical aspects of parallel adaptive BDDC method. In *Proceedings of Applications of Mathematics 2012*, J. Brandts, J. Chleboun, S. Korotov, K. Segeth, J. Šístek, and T. Vejchodský, Eds. Institute of Mathematics AS CR, 2012, pp. 253–266.
8. Čertíková, M., Burda, P., and Šístek, J. Numerical comparison of different choices of interface weights in the BDDC method. In *Proceedings of Applications of Mathematics 2012*, J. Brandts, J. Chleboun, S. Korotov, K. Segeth, J. Šístek, and T. Vejchodský, Eds. Institute of Mathematics AS CR, 2012, pp. 55–61.
9. Burda, P., Novotný, J., and Šístek, J. Analytical solution of Stokes flow near corners and applications to numerical solution of Navier-Stokes equations with high precision. In *Proceedings of Applications of Mathematics 2012*, J. Brandts, J. Chleboun, S. Korotov, K. Segeth, J. Šístek, and T. Vejchodský, Eds. Institute of Mathematics AS CR, 2012, pp. 43–54.
10. Burda, P., Novotný, J., and Šístek, J. Singularities in lid driven cavity solved by adjusted finite element method. In *Computational Fluid Dynamics 2010, Proceedings of 6th ICCFD*

Conference, St. Petersburg, Russia, July 12–16, 2010, A. Kuzmin, Ed. Springer, 2011, pp. 799–805.

11. Kolář, V., Moses, P., and Šístek, J. Triple Decomposition Method for Vortex Identification in Two-Dimensional and Three-Dimensional Flows. In *Computational Fluid Dynamics 2010, Proceedings of 6th ICCFD Conference, St. Petersburg, Russia, July 12–16, 2010*, A. Kuzmin, Ed. Springer, 2011, pp. 225–231.
12. Šístek, J., Burda, P., Mandel, J., Novotný, J., and Sousedík, B. A parallel implementation of the BDDC for the Stokes flow. In *Computational Fluid Dynamics 2010, Proceedings of 6th ICCFD Conference, St. Petersburg, Russia, July 12–16, 2010*, A. Kuzmin, Ed. Springer, 2011, pp. 806–812.
13. Čertíková, M., Burda, P., Novotný, J., and Šístek, J. Some remarks on averaging in the BDDC method. In *Proceedings of Programs and Algorithms of Numerical Mathematics 15, Dolní Maxov, Czech Republic, June 6–11, 2010*, T. Vejchodský et al., Eds. Institute of Mathematics AS CR, Praha, 2010, pp. 28–34.
14. Šístek, J., Burda, P., Mandel, J., Novotný, J., and Sousedík, B. On a parallel implementation of the BDDC method and its application to the Stokes problem. In *Parallel Computational Fluid Dynamics, Recent Advances and Future Directions*, R. Biswas, Ed. DEStech Publications, Lancaster, USA, 2010, pp. 289–296.
15. Burda, P., Novotný, J., and Šístek, J. Accuracy Analysis Based on A Posteriori Error Estimates of SemiGLS Stabilization of FEM for Solving Navier-Stokes Equations. In *Computational Fluid Dynamics 2008, Proceedings of 5th ICCFD Conference, Seoul, South Korea, July 7–11, 2008*, H. Choi, and J. Yoo, Eds. Springer, 2009, pp. 315–320.
16. Burda, P., Novotný, J., and Šístek, J. Semi-GLS stabilization of FEM applied to incompressible flows with higher Reynolds numbers. In *Computational Fluid Dynamics 2006, Proceedings of 4th ICCFD Conference, Ghent, Belgium, July 10–14, 2006*, H. Deconinck and E. Dick, Eds. Springer, 2009, pp. 203–208.
17. Šístek, J., Burda, P., Čertíková, M., and Novotný, J. On Construction of The Coarse Space in the BDDC Method. In *Proceedings of Programs and Algorithms of Numerical Mathematics 14, Dolní Maxov, Czech Republic, June 1–6, 2008*, J. Chleboun et al., Eds. Institute of Mathematics AS CR, Praha, 2008, pp. 177–184.
18. Burda, P., Novotný, J., and Šístek, J. Accuracy investigation of a stabilized FEM for solving flows of incompressible fluid. In *Proceedings of Programs and Algorithms of Numerical Mathematics 13, Praha, Czech Republic, May 28–31, 2006*, J. Chleboun et al., Eds. Institute of Mathematics AS CR, Praha, 2006, pp. 30–36.
19. Burda, P., Novotný, J., Sousedík, B., and Šístek, J. Finite element mesh adjusted to singularities applied to axisymmetric and plane flow. In *Proceedings of Numerical Mathematics and Advanced Applications (ENUMATH), Praha, Czech Republic, August 18–22, 2003*, M. Feistauer et al., Eds. Springer, Berlin, 2004, pp. 186–195.
20. Burda, P., Novotný, J., and Šístek, J. Accurate solution of corner singularities in axisymmetric and plane flows using adjusted mesh of finite elements. In *Computational Fluid Dynamics 2006, Proceedings of 3rd ICCFD Conference, Toronto, Canada, July 12–16*, C. Groth and D. W. Zingg, Eds. Springer, 2004, pp. 463–468.
21. Burda, P., Novotný, J., Sousedík, B., and Šístek, J. A priori and a posteriori error estimates for Navier-Stokes equations applied to incompressible flows. In *Proceedings of Programs and Algorithms of Numerical Mathematics 12, Dolní Maxov, Czech Republic, June 6–11, 2004*, J. Chleboun et al., Eds. Institute of Mathematics AS CR, Praha, 2004, pp. 24–33.

Edited books of proceedings

1. Chleboun, J., Přikryl, P., Segeth, K., Šístek, J., and Vejchodský, T., Eds. *Proceedings of Seminar Programs and Algorithms of Numerical Mathematics 15* (Prague, 2015), Institute of Mathematics, Academy of Sciences of the Czech Republic.
2. Brandts, J., Korotov, S., Křížek, M., Šístek, J., and Vejchodský, T., Eds. *Proceedings of the International Conference Applications of Mathematics 2013, in honor of the 70th birthday of Karel Segeth* (Prague, 2013), Institute of Mathematics, Academy of Sciences of the Czech Republic.
3. Chleboun, J., Segeth, K., Šístek, J., and Vejchodský, T., Eds. *Proceedings of Seminar Programs and Algorithms of Numerical Mathematics 16* (Prague, 2013), Institute of Mathematics, Academy of Sciences of the Czech Republic.
4. Brandts, J., Chleboun, J., Korotov, S., Segeth, K., Šístek, J., and Vejchodský, T., Eds. *Proceedings of the International Conference Applications of Mathematics 2012, in honor of*

the 60th birthday of Michal Křížek (Prague, 2012), Institute of Mathematics, Academy of Sciences of the Czech Republic.

5. Vejchodský, T., Chleboun, J., Přikryl, P., Segeth, K., and Šístek, J., Eds. *Proceedings of Seminar Programs and Algorithms of Numerical Mathematics 15* (Prague, 2010), Institute of Mathematics, Academy of Sciences of the Czech Republic.

Other selected publications

1. Šístek, J. Parallel Implementation of the Multilevel BDDC Method. In *Science and Supercomputing in Europe, research highlights 2010*, Cineca, Bologna, Italy, 2010, p. 142.
2. Šístek, J., Golda, M., and Prokš, M. Calculation of Aerodynamic Characteristics of L-610 Aircraft by AVL and Digital Datcom. *Czech Aerospace Proceedings 2/2007*, pp. 24–28.
3. Šístek, J. Development of parallel solver for systems of linear equations based on BDDC method. In *Science and Supercomputing in Europe 2005*, CINECA, Bologna, Italy, 2006, pp. 603–611.