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André Massing

Personal Information

Family Name Massing
First Name André
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Research Interest

My research interests center around numerical methods for partial differential equations, with focus on the numerical analysis and implementation of finite element methods for complex interface and multiphysics problems. The overarching research theme is the development of novel *unfitted*, also called *cut* finite element methods (CutFEMs) which allow for a flexible representation of complicated and evolving geometries independent of the underlying mesh, without compromising the stability and approximation qualities of the discretization scheme. During my Ph.D. and previous postdoc position, I developed fictitious domain and overlapping mesh methods for complex flow and fluid–structure interaction problems. Recently, I have been working on finite element methods for embedded surfaces and coupled surface–bulk problems, with potential application to multidimensional multiphysics problems describing, e.g., flow and transport problems in fractured porous media, cell motility, and two-phase flows with surfactants.

Education

- 2012 **Ph.D. in Computational Mathematics.**
Faculty of Mathematical and Natural Sciences, University of Oslo, Norway
- 2007 **Diploma in Mathematics (German master equivalent).**
Department of Mathematics and Computer Science, Freie Universität Berlin, Germany

Current and Previous Positions

- 2015–present **Postdoctoral fellow.**
Department of Mathematics and Mathematical Statistics, Umeå University, Sweden
- 2012–2014 **Postdoctoral fellow.**
Center for Biomedical Computing, Simula Research Laboratory, Norway

- 2009–2012 **Ph.D. student.**
Center for Biomedical Computing, Simula Research Laboratory, Norway
- 2007–2009 **Research and development scientist.**
JCMwave GmbH, Berlin, Germany
- 2005–2007 **Scientific student assistant.**
Department for Numerical Mathematics, Konrad Zuse Institute, Berlin, Germany

Career breaks

- 2015/01–05 **Paternity leave (4 months).**

Grants

- 2016 **Postdoctoral scholarship from the Kempe foundation.**
This grant provides funding to hire a postdoctoral fellow within the project “A Virtual Laboratory For Microdroplet Systems”.
- 2015 **Wallenberg travel grant.**
Provided additional funding to attend the conference on eXtended Discretization Methods (X-DMS) 2015, in Ferrara, Italy.
- 2015–2016 **Allocation of high-performance computing resources.**
Granted 60.000 core-hours/year from the High-Performance Computing Center North (HPC2N) within the project “HPC for cut finite element methods”.

Supervision of Graduate Students and Research Fellows

- 2013–2015 **Postdoctoral supervision.**
- Susanne Claus, University College London (now Cardiff University), 2013-2015. Mentoring her during her 3 month research visit at Simula Research Laboratory (Oslo, Norway) and several subsequent short-term visits.
- 2013–present **Ph.D. candidate supervision.**
- Benedict Schott, Institute for Computational Mechanics, Technische Universität München, Germany, with Wolfgang Wall as main supervisor, 2013–2016.
 - Tobias Jonsson, UMIT Research Lab, Umeå University, Sweden, with Mats G. Larson and Karl Larsson as main supervisors, 2015–present.
- 2013–2014 **MSc thesis supervision.**
- Jarle Sogn, *Stabilized Finite Element Methods for the Brinkman Equation on Fitted and Fictitious Domains*, University of Oslo, Department of Informatics, with Kent-Mardal Andre (main-supervisor), 2013–2014.
 - Tom Nærland, *Geometry decomposition algorithms for the Nitsche method on unfitted geometries*, University of Oslo, Department of Informatics, with Kent-Mardal Andre (co-supervisor), 2013–2014.
 - Timo Koch, *Coupling a vascular graph model and the surrounding tissue to simulate flow processes in vascular networks*, University of Stuttgart, Institute for Modelling Hydraulic and Environmental Systems, with Rainer Helmig (principle supervisor), Kent-Andre Mardal (supervisor), 2013–2014.

Teaching Activities

- 2016/11–
2017/01 **Lecturer**, “Numerical Methods for Partial Differential Equations” (58020HT16), 7.5 ECTS, Umeå University, Umeå, Sweden.

- 2016/03–06 **Lecturer**, together with Karl Larsson, “The Finite Element Method” (58121VT16), 7.5 ECTS, Umeå University, Umeå, Sweden.
- 2015/11 **Lecturer**, 1 day FEniCS short course, Umeå University, Umeå, Sweden.
- 2015/10 **Guest lecturer**, Computational Fluid Dynamics (53007 HT15), Umeå University, Umeå, Sweden.
- 2012/07 **Invited lecturer**, 10 days FEniCS workshop as part of the “Instructional Workshop on FEM”, TIFR Center for Applicable Mathematics, Bangalore, India.
- 1999–2004 **Teaching assistant**, several courses (8) on “Mathematics for Physicists”, “Mathematics for Biologists”, University of Potsdam, Germany.

Institutional Responsibilities

- 2014 Bord member (employee representative), Simula School of Research and Innovation, Norway
- 2002 Elected member of the student representatives, University of Potsdam, Germany
- 2002 Elected student representative on the department governance committee, University of Potsdam, Germany
- 2002 Elected student representative on the numerical mathematics professor search committee, University of Potsdam, Germany

Professional Activities

- **Member of local organization committees:** *ECCOMAS thematic/IACM special interest conference on eXtended Discretization MethodS (X-DMS) 2017* i Umeå, Sverige (2015-2017); *26th Nordic Seminar on Computational Mechanics (NSCM 26)* i Oslo, Norge (2013)
- **Organizer of workshops and minisymposia:** *Methods for Cut and Composite Meshes: Theory, Algorithms and Applications* at ECCOMAS 16, Crete, Greece (2016/09); *Unfitted discretization methods for PDEs on embedded manifolds and coupled manifold-bulk problems* at X-DMS, Ferrara, Italy (2015/09); *Advanced Discretization Methods for Interface Problems: Theory, Algorithms and Applications* at USNCCM13, San Diego, USA (2015/07); *Methods for Cut and Composite Meshes: Theory, Algorithms and Applications* at ECFD V, Barcelona, Spain (2014/07); *Computational Modeling with Applications in Biomedicine and Geophysics*, Simula Research Laboratory, Oslo (2014/10); *Methods for Cut and Composite Meshes: Theory, Algorithms and Applications* at USNCCM12, Raleigh, USA (2013/07); *Fixed-grid methods and applications to multi-physics and domain bridging problems* at SIAM CSE 2013, Boston, USA (2013/01);
- **Editor** of the Proceedings of the 26th Nordic Seminar on Computation Mechanics (NSCM 26), Oslo, Norway
- **Referee** for 7 scientific journals: ACM Transactions on Mathematical Software, Computer Methods in Applied Mechanics and Engineering, Journal for Numerical Methods in Fluids, Numerische Mathematik, SIAM Journal for Scientific Computing, SIAM Journal for Numerical Analysis, The Arabian Journal for Science and Engineering

Research Visits

Department of Mathematics, University College London, UK (2015/11–2015/12); Department of Hydromechanics and Modelling of Hydrosystems, University of Stuttgart, Germany (2015/02); Department of Mathematics, University College London, UK (2014/11); Department of Mathematics and Mathematical Statistics, University in Umeå, Sweden (2013/12); Laboratory for Modeling and Scientific Computing MOX, Politecnico di Milano, Milan, Italy (2013/11); Department of Mathematics, University College London, UK (2013/08); Department of Mathematics, University College London, UK (2013/03); Department of Engineering, University of Cambridge, UK (2013/01); Institute for Computational Mechanics, Technische Universität München, Munich, Germany (2012/12); Department of Mechanical Engineering, Technical University of Darmstadt, Germany (2012/11); Department of Mathematics, University of Sussex, Brighton, UK (2012/11); Department of Mathematics and Mathematical Statistics, University in Umeå, Sweden (2012/10); Department of Mathematics and Mathematical Statistics, University in Umeå, Sweden (2011/11–2012/01);

Invited Talks and Conference Presentations

SIMAI 2016, Minisymposium on *Geometrically Unfitted Finite Element Methods*, Milan, Italy (2016/09); ECCOMAS Congress 2016, Minisymposium on *Innovative Non-Boundary-Fitted Discretization Method*, Crete, Greece (2016/06); Workshop on *Geometrically Unfitted Finite Element Method*, University College London, UK (2016/01); Inverse Problems Seminar Series, University College London, UK (2015/12); Workshop on *Geometrically Unfitted Finite Element Method*, RWTH Aachen, Germany (2015/06); FEF2015 conference, Minisymposium on *Higher-Order and DG Methods* Taipei, Taiwan (2015/03); NUPUS Seminar, University of Stuttgart, Germany (2015/01); ECMI 2014, Mini-symposium on FEniCS, Taormina, Italy (2014/06); Conference on *Advances in Computational Fluid-Structure Interaction and Flow Simulation* celebrating the 60th birthday of Tayfun E. Tezduyar, Tokyo, Japan (2014/03); Mox Seminar, Politecnico di Milano, Milan, Italia (2013/11); Department of Mathematics, University College London, UK (2013/08); AMCG Seminar, Imperial College, London, UK (2013/03); ACM Seminar, Institute for Computational Mechanics, Technische Universität München, Munich, Germany (2012/12); CE Seminar, Graduate School of Excellence Computational Engineering, Darmstadt, Germany (2012/11); Department of Mechanical Engineering, Technical University of Darmstadt, Germany (2012/11); Department of Mathematics, University of Sussex, Brighton, UK (2012/11); Department of Mathematics and Mathematical Statistics, University in Umeå, Sweden (2011/12);

Conference Presentations

FEniCS 16, Oslo, Norway (2016/05); X-DMS 2015, Ferrara, Italy (2015/09); USNCCM13, San Diego, USA (2015/07); FEF 2015, Taipei, Taiwan (2015/02); XFEM 2013, Lyon, France (2013/09); USNCCM12, Raleigh, North Carolina, USA (2013/07); Coupled Problems 2013, Ibiza, Spain (2013/06); FEniCS 2013, Cambridge, UK (2013/03); FEF2013, San Diego, USA (2013/03); CSE2013, Boston, USA (2013/02); Chemnitz FEM Symposium, Chemnitz, Germany (2012/09); FEniCS 12, Oslo, Norway (2012/06); FEniCS 11, Lubbock, Texas, USA (2011/11); Coupled Problems 2011, Kos, Greece (2011/06); FEF2011, Munich, Germany (2011/03); CSE2011, Reno, Nevada, USA (2011/02); FEniCS 10, Stockholm, Sweden (2010/05);

Software

Complementing my theoretical work, the second cornerstone of my research is the efficient realization of the proposed unfitted finite element methods. During my Ph.D. studies I developed an open source finite element library for the simulation of coupled PDEs on embedded and overlapping meshes (<https://launchpad.net/dolfin-olm>). The library provided an extension module to the FEniCS project (<https://fenicsproject.org>), a finite element software suite for efficient automated computation of partial differential equations. DOLFIN-OLM is now superseded by overlapping and multimesh technologies which are directly incorporated in the FEniCS core packages. I am initiator and one of the main developers of the open source FEniCS-based software library libCutFEM for cut finite element technologies, which already serves as the daily testing and development platform for my current research activities. The review paper [A7] includes illustrative examples of the already existing capabilities of libCutFEM. A first official release is scheduled for autumn 2016.

Publications

Articles in International Journals

- [A1] Burman, E., Hansbo, P., Larson, M. G., Massing, A., and Zahedi, S. Full gradient stabilized cut finite element methods for surface partial differential equations. *Comput. Methods Appl. Mech. Engrg.*, 310:278–296, October 2016.
- [A2] Burman, E., Hansbo, P., Larson, M., and Massing, A. A cut discontinuous Galerkin method for the Laplace–Beltrami operator. *IMA J. Numer. Anal.*, 2016.
- [A3] Massing, A., Larson, M. G., Logg, A., and Rognes, M. A Nitsche-based cut finite element method for a fluid-structure interaction problem. *Commun. Appl. Math. Comput. Sci.*, 10(2):97–120, 2015.
- [A4] Burman, E., Claus, S., and Massing, A. A stabilized cut finite element method for the three field Stokes problem. *SIAM J. Sci. Comput.*, 37(4):A1705–A1726, 2015.
- [A5] Massing, A., Larson, M., Logg, A., and Rognes, M. A stabilized Nitsche overlapping mesh method for the Stokes problem. *Num. Math.*, 128(1):73–101, September 2014.
- [A6] Massing, A., Larson, M., Logg, A., and Rognes, M. A stabilized Nitsche fictitious domain method for the Stokes problem. *J. Sci. Comput.*, 61(3):604–628, 2014.
- [A7] Burman, E., Claus, S., Hansbo, P., Larson, M., and Massing, A. CutFEM: discretizing geometry and partial differential equations. *Int. J. Numer. Meth. Engng*, 2014.
- [A8] Massing, A., Larson, M., and Logg, A. Efficient implementation of finite element methods on non-matching and overlapping meshes in 3d. *SIAM J. Sci. Comput.*, 35(1):C23–C47, 2013.

Preprints and Submitted Articles

- [PP1] Massing, A., Schott, B., and Wall, W. A stabilized Nitsche cut finite element method for the Oseen problem. *submitted for publication*, 2016.
- [PP2] Burman, E., Hansbo, P., Larson, M. G., and Massing, A. Cut Finite Element Methods for Partial Differential Equations on Embedded Manifolds of Arbitrary Codimensions. *submitted for publication*, 2016.
- [PP3] Burman, E., Hansbo, P., Larson, M. G., Larsson, K., and Massing, A. Finite Element Approximation of the Laplace-Beltrami Operator on a Surface with Boundary. *ArXiv e-prints*, September 2015.
- [PP4] Larson, M. G. and Massing, A. L^2 -error estimates for finite element approximations of boundary fluxes. *available as arXiv preprint arXiv:1401.6994*, 2014.

Refereed Proceedings

- [RP1] Claus, S., Massing, A., and Burman, E. CutFEM: a stabilised Nitsche XFEM method for multi-physics problems. In *Proceedings of the 23 rd UK Conference of the Association for Computational Mechanics in Engineering*, 2015.
- [RP2] Claus, S., Massing, A., and Burman, E. A stabilized Nitsche fictitious domain formulation for the three-field Stokes problem. In *Proceedings of the 26th Nordic Seminar on Computational Mechanics*, 2013.
- [RP3] Massing, A., Larson, M., and Logg, A. Towards an implementation of Nitsche's Method on Overlapping Meshes in 3D. In *AIP Conference Proceedings*, volume 1281, page 783, 2010.

Theses

- [T1] Massing, A. *Analysis and Implementation of Finite Element Methods on Overlapping and Fictitious Domains*. PhD thesis, Department of Informatics, University of Oslo, 2012.
- [T2] Massing, A. 1D-Reduktion thermal signifikanter Aderstränge in der Hyperthermie-Modellierung. Master's thesis, Department of Mathematics and Computer Science, Freie Universität Berlin, 2007.