THE 26TH INTERNATIONAL DOMAIN DECOMPOSITION CONFERENCE DD XXVI

Online, December 7–12, 2020

Hosted by the Chinese University of Hong Kong

CONFERENCE PROGRAM

Sponsors

Useful information

- All talks will be conductive live via the Zoom platform. If you do not have Zoom, you may download it at https://zoom.us/download.
- All zoom links are posted on the attendees-only portion of the conference website at https://www.math.cuhk.edu.hk/conference/dd26/?Attendee_Only-Attendee_Login. All registered participants should have received an e-mail with the username and password.
- For the benefit of participants who cannot attend certain sessions due to timezone reasons, we will record all plenary, minisymposium and contributed talks, as long as we have the consent from the respective speakers. Recordings will be accessible soon after the session concludes, and will be available for viewing for up to one week after the end of the conference.
- For technical support or any inquiries, please send an e-mail to dd26@math.cuhk.edu.hk.

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Schedule at a Glance

All dates and times are shown in local time in Hong Kong. The following table can be used to convert between time zones.

Hong Kong	Europe (CET)	North America (EST)	North America (PST)
10:00	03:00	21:00 (−1 day)	18:00 (−1 day)
16:00	09:00	03:00	00:00
20:00	13:00	07:00	04:00
22:00	15:00	09:00	06:00

Monday Dec 7					
22:00-22:15	**Opening Remarks**				
22:15-23:00 23:00-23:45	**PT-01 Plenary Session** (Chair: Jun Zou) Ulrich Langer Victorita Dolean				
Tuesday Dec 8					
10:00-12:00	**MS4-01** Cai M. Lee P. Fu S.	**MS5-01** Chen Z. Cui T. Duan H.	**CT1** Yazdani Xu K.-L. Fang L. Cai M.		
16:00-18:00	**MS1-01** Sheng H. Chung Yokota Lee C.-O.	**MS2-01** Vergara Laadhari Birken Clement	**MS3-01** Bootland Ma C. Bouziani Dai R.	**MS4-02** Notay Xie M. Wang W. Zheng H.	**MS10-01** Ciaramella Papez Zampini
20:00-22:00	**MS1-02** Weber Gu L. Kopanicakova Heinlein	**MS2-02** Vanzan Hennicker Kwok Tang	**MS3-02** Gong S. Zhang H. Dwarka	**MS10-02** Sistek Hanek Oh D.S. Tomasi	**MS18-01** Alrabeei Peterseim Li G. Pun S. M.
22:15-23:00 23:00-23:45	**PT-02 Plenary Session** (Chair: Petter Bjørstad) Mary Wheeler Adrianna Gillman				
Wednesday Dec 9					
16:00-18:00	**MS4-03** Hou T. Liu F. Wang F. Cui J.	**MS5-02** Wang B. Wu H. Xiang X. Lu W.	**MS11-01** Rheinbach Röver Chen R. Lanser	**CT2** Sarkar Kim H.H. El-Gharbi Kornhuber	
20:00-22:00	**MS5-03** Yin T. Yang W. Zheng C. Zheng W.	**MS6** Thery Genseberger Ye Q. Tang H.	**MS7-01** Scacchi Widlund Dohrmann	**MS11-02** Uran Köhler Heinlein Hochmuth	**MS18-02** Legoll Marcinkowski Yu Y. Galvis
22:15-23:00 23:00-23:45	**PT-03 Plenary Session** (Chair: Laurence Halpern) Zdenek Dostal Patrick Joly				

Thursday Dec 10					
	MS7-02	**MS8-01**	**MS16-01**	**MS17-01**	**CT3**
16:00-18:00	Cho	Leng W.	Ayuso de Dios	Cai X.-C.	Kinnewig
	Takacs	Laayouni	Antonietti	McCoid	Hocking
	Schneckenleitner	Van Criekingen	Zhao	Lanser	Krzyzanowski
		Kyriakis	Kim D.H.	Liu L.	
	MS12	**MS15-01**	**MS18-03**	**MS19**	**MS20-01**
19:30-20:00				Alonso Rodriguez	
20:00-22:00	Tromeur-Dervout	Tu X.	Borges	Kogler	Boubendir
	Glusa	Zhang Z.W.	Rahman	Wang K.	Claeys
	Szyld	Li K.	Faal	Li Y.	Gander
	Chaouqui		Bjørstad	Garay	Krell
	PT-04 Plenary Session (Chair: Xiao-Chuan Cai)				
22:15-23:00	Rolf Krause				
23:00-23:45	Eric Chung				
Friday Dec 11					
	MS8-02	**MS15-02**	**MS16-02**	**MS21-01**	
10:00-12:00	Chang H.	Wu Z.	Wang J.	Lee H.S.	
	Zhang Z.K.	Li M.	Kim M.-Y.	Banks	
	Lucero	Xiong J.	Park E.-H.	Hoang	
	Xu Y.	Liao Q.	Shin D.-W.	Sockwell	
	MS8-03	**MS9-01**	**MS17-02**	**CT4**	
16:00-18:00	Outrata	Zank	Klawonn	Thies	
	Song B.	Lunet	Gu Y.	Huynh	
	Quan C.	Schafelner	Hwang	Madiot	
		Pacheco	Kumbhar	Shourick	
	MS9-02	**MS13-01**	**MS20-02**	**MS21-02**	**CT5**
20:00-22:00	Zikatanov	Salomon	Modave	Wick	Arraras
	Speck	Mechelli	Nicolopoulos	Durst	Sogn
	Lenz	Delourme	Parolin	Trenchea	Mohammad
	Steinbach	Ciaramella	Pechstein	Fu G.	
	PT-05 Plenary Session (Chair: Susanne Brenner)				
22:15-23:00	Laurence Halpern				
23:00-23:45	Xuemin Tu				
Saturday Dec 12					
	MS13-02|*MS20-03*	**MS17-03**	**MS22**	**MS14**	**CT6**
20:00-22:00	Reyes-Riffo	Keyes	Boon	Knepper	Park J.H.
	Yang H.D.	Luo L.	Niu C.	Song B.	Rhofir
	Royer	Kothari	Cavanaugh	Rave	Schanen
	Lunowa	Yang H.J.	Ohm	Chaouqui	Barrata
	PT-06 Plenary Session (Chair: Martin J. Gander)				
22:15-23:00	Carola Schönlieb				
23:00-23:45	Shuonan Wu				
23:45-00:00	**Closing remarks**				

Plenary Lectures

Ulrich Langer –Adaptive Space-Time Finite Element and Isogeometric Analysis

Monday 22:15–23:00

The traditional approaches to the numerical solution of initial-boundary value problems for parabolic or hyperbolic Partial Differential Equations (PDEs) are based on the separation of the discretization in time and space leading to time-stepping methods. This separation of time and space discretizations comes along with some disadvantages with respect to parallelization and adaptivity. To overcome these disadvantages, we consider completely unstructured finite element or isogeometric (B-spline or NURBS) discretizations of the space-time cylinder and the corresponding stable space-time variational formulation of the initial-boundary value problem under consideration. Unstructured space-time discretizations considerably facilitate the parallelization and simultaneous space-time adaptivity. Moving spatial domains or interfaces can easily be treated since they are fixed in the space-time cylinder. Beside initial-boundary value problems for parabolic PDEs, we will also consider optimal control problems constraint by linear or non-linear parabolic PDEs. Here unstructured space-time methods are especially suited since the optimality system couples two parabolic equations for the state and adjoint state that are forward and backward in time, respectively. In contrast to time-stepping methods, one has to solve one big linear or non-linear system of algebraic equations. Thus, the memory requirement is an issue. In this connection, adaptivity, parallelization, and matrix-free implementations are very important techniques to overcome this bottleneck. Fast parallel solvers like domain decomposition and multigrid solvers are the most important ingredients of efficient space-time methods.
The talk is based on joint works with Christoph Hofer, Martin Neumüller, Svetlana Kyas (Matculevich), Sergey Repin, Andreas Schafelner, Rainer Schneckenleitner, Olaf Steinbach, Ioannis Toulopoulos, Fredi Tröltzsch, and Huidong Yang. This research was supported by the Austrian Science Fund (FWF) through the projects NFN S117-03 and DK W1214-04. This support is gratefully acknowledged.

Victorita Dolean –Robust Solvers for Time-Harmonic Wave Propagation Problems

Monday 23:00–23:45

Time harmonic wave propagation problems are notoriously difficult to solve especially in high frequency regime. Several reasons are at the origin of this: first of all the oscillatory nature of the solution, meaning that the number of degrees of freedom after discretisation increases drastically with the wave number (especially for lower order approximations) giving rise to complex valued large problems to solve. Secondly, the indefiniteness of the operator: its spectral properties only making it difficult to control and predict the behaviour of a Krylov type solver. Not to mention the inherent challenges when the wave propagation takes place in a heterogeneous medium. We try to answer partially to some of the questions (with strong numerical evidence) by proposing a few methods which proved to be robust with respect to the wave number for different equations such as: Helmholtz, Maxwell or elastic waves. These methods are further applied to heterogeneous physically realistic problems arising in electrical engineering and geophysics.

Mary F. Wheeler –Domain Decomposition for Modeling Two-Phase Flow in Porous Media

Tuesday 22:15–23:00

Convergence failure and slow convergence rates are among the major challenges in solving the system of nonlinear equations arising in modeling two phase flow in porous media. Although mitigated, such issues still linger when using strictly small time steps and unconditionally stable fully implicit schemes. The price that comes with restricting time steps to small scales is the enormous computational load, especially in large-scale models. To address this problem, we introduce a sequential domain decomposition local mesh refinement framework based on enhanced velocity methods (EVM). EVM is a locally conservative mixed finite element scheme that allows non-matching grids. Here we have extended EVM to treat temporal and spatial adaptivity. Two type of error estimators are introduced to estimate the spatial discretization error

and the temporal discretization error separately. These estimators provide a global upper bounds on the dual norm of the residual and the non-conformity of the numerical solution for non-linear two phase flow models. The mesh refinement algorithm starts from solving the problem on the coarsest space-time mesh, then the mesh is refined sequentially based on the spatial error estimator and the temporal error estimator. After each refinement, the solution from the previous mesh is used to estimate the initial guess of unknowns on the current mesh for faster convergence. The flexibility of this framework allows for improved convergence and efficiency and and prevents convergence failure, while not restricting the whole system to small time steps, Numerical results are presented to confirm accuracy of this algorithm as compared to the uniformly fine time step and fine spatial discretization solution. We observe around 25 times speedup in the solution time by using our algorithm. This work was done in collaboration with Hanyu Li of the University of Texas at Austin and Wing Tat Leung of the University of California at Irvine.

Adrianna Gillman –An Efficient and High Order Accurate Direct Solution Technique for Variable Coefficient Elliptic Partial Differential Equations

Tuesday 23:00–23:45

For many applications in science and engineering, the ability to efficiently and accurately approximate solutions to elliptic PDEs dictates what physical phenomena can be simulated numerically. In this talk, we present a high-order accurate discretization technique for variable coefficient PDEs with smooth coefficients. The technique can be viewed as a domain decomposition method applied at the element level where the coupling conditions are applied directly. The linear system resulting from the discretization can be solved via a nested dissection inspired direct solver that scales linearly or nearly linearly with respect to the number of unknowns. The discretization is robust even for problems with highly oscillatory solutions. For example, a Helmholtz problem where the geometry is 100 wavelengths in size can be solved to 9 digits of accuracy with 3.7 million unknowns. The precomputation of the direct solver takes 6 minutes on a desktop computer and applying the computed solver takes 3 seconds. A parallel implementation of the solution technique reduces the precomputation time to roughly 30 seconds and halves the time it takes to apply the solver. Applications of the solution technique to free-space scattering and inverse scattering problems will also be presented.

Zdeněk Dostál –Improving Efficiency of Scalable TFETI/BETI Contact Solvers for Huge Problems

Wednesday 22:15–23:00

The development of scalable solvers for contact problems is a challenging task due to a priori unknown contact conditions which make the problem strongly nonlinear. In the first part of the lecture, we specify the challenges and present the tools that can be used to overcome them. We first briefly review the *TFETI/TBETI* (total finite/boundary element tearing and interconnecting) based domain decomposition methodology adapted to the solution of contact problems of elasticity discretized by matching grids. The scalability of the proposed method is based on a combination of classical estimates due to Farhat, Mandel, and Roux with the results on the rate of convergence of some special quadratic programming and QCQP (quadratic programming – quadratic constraints) algorithms. The theory guarantees that an approximate solution with prescribed relative error can be obtained in $O(1)$ matrix–vector multiplications provided the cost of the projector to the "natural coarse grid" does not dominate the computation. The results apply to the multibody frictionless problems, both static and dynamic, and to the problems with a given (Tresca) friction.

In the rest, we present three extensions starting with *mortar discretization* of the contact conditions for non-matching grids on the contact interface. The generalization is non-trivial due to the not obvious conditioning of inequality constraints. Improved numerical results are obtained by means of *adaptive augmentation* that enhances into the augmented Lagrangian algorithm the information about the current estimate of the active set of the solution.

The next improvement is the *re-orthogonalization based preconditioning* and *re-normalization based scaling*

which enables to extend the scope of applications from the problems with constant coefficients to those with homogeneous subdomains. Though there is a number of results for the problems with jumping coefficients, they typically use the preconditioners transforming separable constraints into more general ones that cannot be treated by specialized algorithms.

Our final goal is to extend the scope of scalability limited by the dimension of the projector. Our tool is the *H-TFETI method*, proposed for linear problems by Klawonn and Rheinbach, and its H-TBETI counterpart. The idea is to join some subdomains by "gluing" corners, edge averages, and face averages on primal level into the clusters with a common rigid body modes. The role of clusters in H-TFETI is the same as the role of subdomains in TFETI. Though we have to avoid preconditioners, it turns out that it is still possible to get results that grant optimal complexity. We give some estimates of the conditioning of clusters and provide numerical results obtained with variants of H-TFETI.

Patrick Joly –Domain Decomposition Methods for Time Harmonic Wave Propagation Problems

Wednesday 23:00–23:45

In this talk, I will survey the research led at INRIA about non overlapping domain decomposition methods for time harmonic wave propagation problems based on generalized impedance transmission conditions. Our approach is theory driven and aims at first priority to enhance the robustness of our methods. We propose a unified framework that proves the well-posedness and the convergence of related iterative algorithms at the continuous level through PDE techniques. Within this framework, which provably follows through in the discrete setting, we shall show how it is possible to improve the speed of convergence through the design of good impedance operators. I will present the recent development on non local transmission operators which allows to achieve linear convergence, with an emphasis on the case of 3D Maxwell's equations.

Rolf Krause –Multilevel Strategies for Non-Linear Problems and Machine Learning: On Non-Linear Preconditioning, Multilevel Optimization, and Multilevel Training

Thursday 22:15–23:00

In this talk, we will discuss the main ideas of multilevel optimization techniques and their relation to classical multigrid theory. We will discuss how multilevel optimization methods for convex and non-convex minimization problems can be constructed and analyzed. We will study the significant gain in convergence speed, which can be achieved by multilevel minimization techniques.

Multilevel optimization techniques are also intimately linked to non-linear preconditioning. As it turns out, the minimization based view on non-linear problems can not only help to design efficient preconditioner, but is also is useful for the construction of globalization strategies.

In the second part of our talk we will employ multilevel optimization techniques in the context of machine learning and will discuss their benefits for the training of neural networks.

Various numerical examples from phase field models for fracture, from non-linear elasticity, and from deep learning will illustrate our findings.

Eric Chung –Local Multiscale Model Reduction and Applications

Thursday 23:00–23:45

Modeling and simulating flow and transport in porous and fracture media are important for many applications. Standard numerical methods are costly in the sense that the dimension of the resulting discrete system is large. To enhance the computational efficiency, model reduction techniques such as upscaling and multiscale methods are necessary, and the resulting systems can be solved on a coarse grid with much smaller degrees of freedoms. In this talk, we will present some recent advances in multiscale model reduction techniques including the generalized multiscale finite element method and the nonlocal multicontinua upscaling. These methodologies are applied successfully to many applications such as poroelasticity, two-phase flow and

seismic wave in heterogeneous fracture media. This is a joint work with Yalchin Efendiev, Wing Tat Leung and Maria Vasilyeva. The research is partially supported by the Hong Kong RGC General Research Fund (Project numbers 14304217 and 14302018) and the CUHK Faculty of Science Direct Grant 2018-19.

Laurence Halpern –Fundamental Coarse Space Components for Schwarz Methods with Crosspoints

Friday 22:15–23:00

Two-level domain decomposition methods have been created in the 1990's to make one-level domain decomposition methods scalable. Over the last decade, new coarse space components have also been designed to treat strong heterogeneities and make domain decomposition methods robust for high contrast problems.

Our focus here is to investigate what coarse space components remain naturally when using one-level Schwarz methods to solve Laplace type problems. We start by presenting a numerical experiment which shows visually what error components a classical parallel Schwarz method can not treat effectively. We then study these components by performing a detailed analysis of the iteration map for parallel Schwarz algorithms for a rectangular domain decomposition including crosspoints. Interestingly, these coarse space components remain the same both for classical and optimized Schwarz methods, and contain discontinuous components across subdomain interfaces.

We then propose an approximation to capture these coarse space components, which can be handled by assembly subdomain by subdomain to obtain a coarse correction operator, and we show numerical experiments to illustrate its performance. We will finally also present a preliminary investigation of such coarse space components for general domain decompositions obtained by METIS.

This is a joint work with François Cuvelier (Université Paris 13) and Martin Gander (Université de Genève)

Xuemin Tu –Nonoverlapping Domain Decomposition Methods for Saddle Point Problems

Friday 23:00–23:45

FETI-DP and BDDC these two most popular nonoverlapping domain decomposition algorithms will be discussed for solving a class of saddle point problems arising from mixed finite element or hybridizable discontinuous Galerkin discretizations of partial differential equations. These algorithms reduce the original saddle point problems to symmetric positive definite problems in a special subspace and therefore the conjugate gradient methods can be used to accelerate the convergence. The condition numbers for the preconditioned systems are estimated and numerical results are provided to confirm the results. These are joint work with Drs. Jing Li, Bin Wang, and Stefano Zampini.

Carola-Bibiane Schönlieb –From Differential Equations to Deep Learning for Image Processing

Saturday 22:15–23:00

Images are a rich source of beautiful mathematical formalism and analysis. Associated mathematical problems arise in functional and non-smooth analysis, the theory and numerical analysis of partial differential equations, harmonic, stochastic and statistical analysis, and optimisation. Starting with a discussion on the intrinsic structure of images and their mathematical representation, in this talk we will learn about some of these mathematical problems, about variational models for image analysis and their connection to partial differential equations and deep learning. The talk is furnished with applications to art restoration, forest conservation and cancer research.

Shuonan Wu –General Convection-Diffusion Problems: Robust Discretizations, Fast Solvers and Applications

Saturday 23:00–23:45

In this talk, we present robust discretizations and fast solvers for $H(\text{grad})$, $H(\text{curl})$ and $H(\text{div})$ convection-diffusion PDEs discretized on unstructured simplicial grids. The derivation of these schemes makes use of some intrinsic properties of differential forms, and in particular, some crucial identities from differential geometry. The schemes are of the class of exponential fitting methods that result in special upwind schemes when the diffusion coefficient approaches to zero. Fast solvers are developed for the linear system arising from the robust discretizations of $H(\text{curl})$ and $H(\text{div})$ convection-diffusion problems, which can be viewed as a natural extension of Hiptmair-Xu preconditioners for the symmetric problems. The solvers exclusively rely on that for $H(\text{grad})$ convection-diffusion problem and the discrete commutative diagram involving the convection terms. Both theoretical analysis and numerical experiments show that the new finite element schemes provide the accurate and robust discretizations and fast solvers in many applications, and in particular, for simulation of magnetohydrodynamics systems when the magnetic Reynolds number R_m is large.

Minisymposia

MS01 – Learning Algorithms, Domain Decomposition Methods, and Applications

Organizers: Xiao-Chuan Cai ◇ Axel Klawonn

Learning algorithms are playing an increasingly important role in data science and also in computational science and engineering. In this mini-symposium, we discuss some recent advances in machine learning, in connection with domain decomposition and multilevel methods, with applications in several areas including the processing of medical images, parameter optimization in scientific computing, and numerical solution of partial differential equations.

Tuesday 16:00–18:00

16:00–16:30 Hailong Sheng
An Overlapping Domain Decomposition Method for Solving Boundary Value Problems Using Artificial Neural Networks.

16:30–17:00 Eric Chung
Learning Multiscale Models Using Nonlocal Upscaling Techniques

17:00–17:30 Rio Yokota
Overview of Distributed Memory Parallelism in Deep Learning

17:30–18:00 Chang-Ock Lee
Parareal Neural Networks Emulating a Parallel-In-Time Algorithm

Tuesday 20:00–22:00

20:00–20:30 Janine Weber
Combining Machine Learning and Adaptive Coarse Spaces to Design Robust and Efficient FETI-DP Methods for Elliptic Problems in Three Dimensions

20:30–21:00 Linyan Gu
Decomposition and Composition of Deep Convolutional Neural Networks and Training Acceleration Via Sub-Network Transfer Learning

21:00–21:30 Alena Kopaničáková
Multilevel Training of Deep Residual Networks

21:30–22:00 Alexander Heinlein
Flow Predictions Using Convolutional Neural Networks

MS02 – Heterogeneous Domain Decomposition Methods: Theoretical Developments and New Applications

Organizers: Martin J. Gander ◇ Tommaso Vanzan

Domain decomposition methods are the natural computational framework for heterogeneous problems. Heterogeneity can arise either because the physics is different in parts of the domain and hence different models need to be used, or because it can be convenient to use a cheaper approximation in some parts of the domain in order to save computational resources. This minisymposium will give an overview of new theoretical and computational developments in the use of domain decomposition methods for heterogeneous problems.

Tuesday 16:00–18:00

16:00–16:30 Christian Vergara
On the Stability and Efficiency of Domain-Decomposition Algorithms for Fluid-Structure Interaction

16:30–17:00 Aymen Laadhari
Fully Eulerian Fluid-Structure Interaction Methods for the Cardiovascular Modeling

17:00–17:30 Philipp Birken
Time Adaptive Multirate DN and NN Waveform Relaxation for Heterogenous Coupled Heat Equations

17:30–18:00 Simon Clement
Tools for Discrete SWR Analysis and Its Features

Tuesday 20:00–22:00

20:00–20:30 Tommaso Vanzan
How to Use Probing to Find Optimized Transmission Conditions

20:30–21:00 Julian Hennicker
Error Estimates for Discrete Fracture Matrix Models

21:00–21:30 Felix Kwok
On the Choice of Optimized Schwarz Parameters for Elliptic Problems with Non-Conforming Heterogeneities

21:30–22:00 Hansong Tang
On Computation of Coupled Advection-Diffusion-Reaction Equations

MS03 – Preconditioning Methods for Frequency Domain Wave Problems

Organizers: Victorita Dolean ◇ Ivan G. Graham

The efficient iterative solution of frequency domain wave problems in the mid- to high-frequency regime is a notoriously difficult problem, because (a) solutions are oscillatory and meshes have to be fine to resolve them; (b) matrices are non Hermitian, highly indefinite and generally non-normal; (c) standard intuition for preconditioning techniques born from the study of SPD elliptic problems is of limited use. Nevertheless these problems are of great practical interest and in recent years substantial progress has been made both in theory and in practice on the construction of effective preconditioners. This minisymposium will highlight recent progress in this challenging area.

Tuesday 16:00–18:00

16:00–16:30 Niall Bootland
Analysis of Parallel Schwarz Algorithms for Time-Harmonic Problems Using Block Toeplitz Matrices

16:30–17:00 Chupeng Ma
Coarse Spaces Based on Geneo Type Eigenvalue Problems for Indefinite Problems

17:00–17:30 Nacime Bouziani
A Splitting Double Sweep Method for the Helmholtz Equation

17:30–18:00 Ruiyang Dai
Parallel Sweeping Preconditioners for Rectangular Domain Decompositions with Cross Points Applied to the Helmholtz Equation

Tuesday 20:00–21:30

20:00–20:30 Shihua Gong
Convergence of Overlapping Domain Decomposition Methods for the Helmholtz Equation

20:30–21:00 Hui Zhang
On the Wavenumber Robustness of Optimized Schwarz Methods for the Helmholtz Equation

21:00–21:30 Vandana Dwarka
Scalable Convergence Using Two-Level Deflation for the Helmholtz Equation

MS04 – Two-Grid Method and Its Applications

Organizers: Hehu Xie ◇ Jinchao Xu ◇ Liuqiang Zhong

Two-grid (two-level/two-space) method is one of the important tools to build fast solvers for the non-symmetric/indefine or nonlinear problems. Since its appearance, the two-grid method have been successfully applied to solve many problems in the last two decades, such as nonlinear elliptic problems, nonlinear parabolic equations, Navier-Stokes problems, Maxwell equations, and eigenvalue problems, etc.
This minisymposium is concerned with the applications of the two-grid, two-scale, multigrid, multiscale and multilevel methods. We hope that the mini symposium is to bring together experts as well as junior researchers with common interest but with diversified backgrounds and knowledge, to discuss new types of questions at the foundation, overlap and applications of this research field.

Tuesday 10:00–11:30

10:00–10:30 Mingchao Cai
Preconditioners for Two-Fold Saddle Point and Block Tridiagonal Systems

10:30–11:00 Pilhwa Lee
Some Domain Decomposition Preconditioners for Poroelastic Model

11:00–11:30 Shubin Fu
A Two-Grid Preconditioner with an Adaptive Coarse Space for Flow Simulations in Highly Heterogeneous Media

Tuesday 16:00–18:00

16:00–16:30 Yvan Notay
Two-Grid Analysis for Nonnormal Matrices

16:30–17:00 Manting Xie
A Multigrid Method for Ground State Solution of the Bose-Einstein Condensates

17:00–17:30 Wansheng Wang
Two-Grid Finite Element Methods for Parabolic Integro-Differential Equations

17:30–18:00 Haibiao Zheng
Expandable Local and Parallel Two-Grid Finite Element Iterative Scheme for the Stokes Equations

Wednesday 16:00–18:00

16:00–16:30 Tianliang Hou
Two-Grid Methods for P_0^2-P_1 Mixed Finite Element Approximation of General Elliptic Optimal Control Problems with Low Regularity

16:30–17:00 Fang Liu
Two-Scale Finite Element Approximations for Semilinear Parabolic Equations

17:00–17:30 Feng Wang
An Unfitted Virtual Element Methods for the Elliptic Interface Problem

17:30–18:00 Jintao Cui
A Two-Grid Finite Difference Algorithm for Compressible Darcy-Forchheimer Model in Porous Media

MS05 – Mini-Symposium on Advanced Numerical Methods for Electromagnetic Problems

Organizers: Zhiming Chen ◇ Liwei Xu ◇ Weiying Zheng

We propose a mini-symposium on efficient numerical methods for electromagnetic problems in DD26. The theme of the mini-symposium concentrates on the design and analysis of efficient numerical methods, and robust and fast discrete system solvers for electromagnetic problems arising in sciences and engineering applications.

Tuesday 10:00–11:30

10:00–10:30 Zhiming Chen
An Adaptive High-Order Unfitted Finite Element Method for Elliptic Interface Problems

10:30–11:00 Tao Cui
Parallel 3-D Adaptive Finite Element Method and Its Application on EDA Tools

11:00–11:30 Huoyuan Duan
Discrete Compactness Holds for Any Order Lagrange Elements for the Classical Formulation $(\mu^{-1}\mathrm{curl}\, u, \mathrm{curl}\, v) = \omega^2(\varepsilon u, v)$ of the Maxwell Eigenproblem

Wednesday 16:00–18:00

16:00–16:30 Bo Wang
An Efficient Iterative Method for Solving Multiple Scattering in Locally Inhomogeneous Media

16:30–17:00 Haijun Wu
A Pure Source Transfer Domain Decomposition Method for Helmholtz Equations in Unbounded Domain

17:00–17:30 Xueshuang Xiang
Double Source Transfer Domain Decomposition Method for Helmholtz Problems

17:30–18:00 Wangtao Lu
Mathematical Analysis of Wave Radiation by a Step-Like Surface

Wednesday 20:00–22:00

20:00–20:30 Tao Yin
A Novel Boundary Integral Equation Method for Elastic Scattering Problems on a Half-Space

20:30–21:00 Wei Yang
Time-Domain Metamaterial Models and Finite Element Simulations

21:00–21:30 Chunxiong Zheng
Space Splitting, Calderon Projection and Discrete Version of Integral Equation Method

21:30–22:00 Weiying Zheng
A Charge-Conservative Finite Element Method for Inductionless Mhd Equations

MS06 – Techniques and Application of Domain Decomposition for Modelling of Environmental Flows

Organizers: Menno Genseberger ◇ Hansong Tang

In recent years, domain decomposition techniques have been incorporated in large computer codes and used for real-life applications. This minisymposium presents recent work in this regard with a twofold aim. On one hand, it illustrates the importance of domain decomposition in the application field, for instance, for modelling flexibility or parallel performance. On the other hand, the minisymposium intends to highlight the applied domain decomposition techniques, to discuss them, and, if needed, to reconsider or further improve them. The minisymposium is restricted to hydrodynamics and aerodynamics based on shallow water flow and Navier-Stokes equations, and it will yield a good basis for further discussion.

Wednesday 20:00–22:00

20:00–20:30 Sophie Thery
Schwarz Algorithms for Ocean-Atmosphere Coupled Problems Including Turbulent Boundary Layers Parameterizations

20:30–21:00 Menno Genseberger
Domain Decomposition in Shallow Water Modelling of Dutch Lakes for Multiple Applications

21:00–21:30 Qinghua Ye
An Improved Weakly Reflective Boundary Condition for Model Nesting in Shallow Waters

21:30–22:00 Hansong Tang
Simulation of Environmental Flows by Coupling Navier-Stokes Equations and Their Hydrostatic Versions

MS07 – Domain Decomposition Methods for Isogeometric and High Order Discretizations

Organizers: Luca F. Pavarino ◇ Olof B. Widlund ◇ Ulrich Langer

This minisymposium will focus on the latest research developments in Domain Decomposition Methods for Isogeometric Analysis (IGA) and other High Order discretizations. IGA is a recent innovative numerical framework for the discretization of Partial Differential Equations (PDEs), based on the integration of Finite Element analysis and Computer Aided Design (CAD) by employing splines and NURBs basis functions in a Galerkin or collocation scheme. The design and analysis of efficient solvers for IGA and other High

Order discretizations present new difficulties, such as the high regularity of the high-order discrete spaces employed, leading to nonstandard interface problems. The talks in this minisymposium will focus on the latest developments in the design, analysis and parallel implementation of novel domain decomposition preconditioners and scalable solvers for IGA and other High Order discretizations.

Wednesday 20:00–22:00

20:00–20:30 Stefano Zampini
Block FETI--DP/BDDC Preconditioners for Mixed Isogeometric Discretizations of Three-Dimensional Almost Incompressible Elasticity

20:30–21:00 Simone Scacchi
Parallel Block Preconditioners for Three-Dimensional Virtual Element Discretizations of Elliptic Equations in Mixed Form

21:00–21:30 Olof B. Widlund
BDDC Deluxe and Isogeometric Analysis - The Impact of Fat Interfaces on Theory and Practice

21:30–22:00 Clark Dohrmann
Spectral Equivalence of Higher-Order Tensor Product Finite Elements and Applications to Preconditioning

Thursday 16:00–17:30

16:00–16:30 Durkbin Cho
Optimal Multilevel Preconditioners for Isogeometric Collocation Methods

16:30–17:00 Stefan Takacs
Condition Number Bounds for IETI-DP Methods That Are Explicit in h and p

17:00–17:30 Rainer Schneckenleitner
Convergence Theory for IETI-DP Solvers for Discontinuous Galerkin Isogeometric Analysis That Is Explicit in h and p

MS08 – New Developments of Domain Decomposition Methods: Non-Standard Methods and Applications

Organizers: Yingxiang Xu ◇ Shu-Lin Wu ◇ Hui Zhang

This minisympsium is for the small streams of domain decomposition methods. We will learn a new Schwarz method based on Perfectly Matched Layers that transmit waves in all dimensions, a reflection on the general theory of Robin-type DDMs and a non-standard parallel-in-time method. Also, we will learn the DDMs for non-standard applications such as nonlinear optimization, image processing and quantum chemistry.

Thursday 16:00-18:00

16:00–16:30 Wei Leng
A Diagonal Sweeping Domain Decomposition Method for the Helmholtz Equation

16:30–17:00 Lahcen Laayouni
Computational Efficiency and Robustness of Algebraic Optimized Schwarz Methods: Promises and Challenges

17:00–17:30 Serge Van Criekingen
New Coarse Corrections in Optimized Schwarz Methods for Symmetric and Non-Symmetric Problems

17:30–18:00 Alexandros Kyriakis
Are Parallel Schwarz Methods for Magnetotelluric Approximations to Maxwell's Equations Scalable?

Friday 10:00–12:00

10:00–10:30 Huibin Chang
Fourier Masked Phase Retrieval: Mask Design, Blind Recovery, and Sparsity Modeling

10:30–11:00 Zaikun Zhang
A Space Decomposition Framework for Nonlinear Optimization

11:00–11:30 Jose Pablo Lucero Lorca
Optimization of Two-Level Methods for DG Discretizations of Reaction-Diffusion Equations

11:30–12:00 Yingxiang Xu
Schwarz Domain Decomposition Methods for the Fluid-Fluid System with Friction-Type Interface Conditions

Friday 16:00–17:30

16:00–16:30 Michal Outrata
Towards Optimized Schwarz Methods with Low-Rank Transmission Conditions

16:30–17:00 Bo Song
A Superlinear Convergence of Parareal Schwarz Waveform Relaxation Algorithm

17:00–17:30 Chaoyu Quan
A Domain Decomposition Method for the Poisson--Boltzmann Solvation Model in Quantum Chemistry

MS09 – Space--Time FEM/BEM: Theory and Applications

Organizers: Ulrich Langer ◇ Olaf Steinbach

In recent years, space-time discretization methods became very popular for the solution of time-dependent partial differentil equations. This is mainly due to the applicability of adaptive resolutions in space and time simultaneousy, and the parallel solution in space and time. Within this minisymposium we will present some of the recent developments of space-time finite and boundary element methods in theory and applications.

Friday 16:00–18:00

16:00–16:30 Marco Zank
A Modified Hilbert Transform and Space-Time Continuous Galerkin Finite Element Methods for the Second-Order Wave Equation

16:30–17:00 Thibaut Lunet
The Advection Curse of Multigrid-In-Time Methods

17:00–17:30 Andreas Schafelner
Locally Stabilized Space-Time Finite Element Methods on Anisotropic Hexahedral Decompositions

17:30–18:00 Douglas R. Q. Pacheco
A Space-Time FETI Method for Incompressible Flow Problems

Friday 20:00–22:00

20:00–20:30 Ludmil Zikatanov
Exponential Fitting for Space-Time Convection Diffusion Problems

20:30–21:00 Robert Speck
PFASST and Finite Elements

21:00–21:30 David Lenz
Mesh Refinement in 4D

21:30–22:00 Olaf Steinbach
Space-Time Boundary and Finite Element Domain Decomposition Methods for Parabolic Problems

MS10 – Multilevel Domain Decomposition Methods and Parallel Implementations

Organizers: Jakub Šístek ◇ Stefano Zampini

The almost exponential growth in computing power of the largest supercomputers has been maintained for the last decade mainly by increasing concurrency at different hardware levels, especially increasing core counts of CPUs and incorporating accelerators, such as GPUs. These hardware developments pose new challenges to domain decomposition (DD) algorithms and their massively parallel implementations. One of the main issues we are facing is solving coarse problems in DD in a scalable way to exploit the mathematical scalability of the algorithms.
The minisymposium brings together researchers working on techniques addressing the issue of the coarse problem solution mainly by employing several levels in the DD methods. The topics include developments in Multilevel BDDC for symmetric and nonsymmetric problems. An emphasis is put on parallel implementations of the methods and applications to large-scale problems.

Tuesday 16:00–17:30

16:00–16:30 Gabriele Ciaramella
Substructured Two-Level and Multi-Level Domain Decomposition Methods

16:30–17:00 Jan Papež
Multilevel Iterative Solver and a Posteriori Algebraic Error Estimator with p-Robust Behavior

17:00–17:30 Stefano Zampini
BDDC Methods and GPUs with PETSc. Current Status and Future Perspectives.

Tuesday 20:00–22:00

20:00–20:30 Jakub Šístek
A Parallel Multilevel BDDC Solver and Its Application to Adaptive FEM

20:30–21:00 Martin Hanek
Multilevel BDDC for Nonsymmetric Systems from Incompressible Flows

21:00–21:30 Duk-Soon Oh
A Multigrid Method for $H(\mathbf{curl})$ with Nonoverlapping Domain Decomposition Smoothers

21:30–22:00 Claudio Tomasi
Construction of Grid Operators for Multilevel Solvers by Means of a Neural Networks Approach

MS11 – Domain Decomposition Methods in HPC: Extremely Scalable Implementations and Their Application

Organizers: Axel Klawonn ◇ Oliver Rheinbach

Nonoverlapping as well as overlapping domain decomposition (DD) methods proved to be robust and efficient parallel linear or nonlinear solvers. Their favorable divide and conquer structure makes them extremely suitable for modern parallel computer architectures and carefully designed coarse spaces deliver robustness and numerical scalability up to large numbers of subdomains and compute cores. In recent years, approximating the global coarse solves by applying efficient parallel solvers as, e.g., algebraic multigrid or DD recursively, facilitated the efficient use of hundreds of thousands of compute cores. In this minisymposium, several state-of-the-art DD approaches, their efficient implementation, and their application to hard real-world problems are presented and discussed.

Wednesday 16:00–18:00

16:00–16:30 Oliver Rheinbach
Preconditioning the Coarse Problem of BDDC - Comparison of Three-Level, Algebraic Multigrid, and Vertex-Based Preconditioners

16:30–17:00 Friederike Röver
A Three-Level Extension for the Fast and Robust Overlapping Schwarz (FROSch) Preconditioner

17:00–17:30 Rongliang Chen
Large Eddy Simulation of the Wind Flow in a Realistic Full-Scale Urban Community with a Scalable Parallel Algorithm

17:30–18:00 Martin Lanser
A Frugal FETI-DP and BDDC Coarse Space for Heterogeneous Problems - Comparison with Competing Coarse Spaces and Parallel Results

Wednesday 20:00–22:00

20:00–20:30 Matthias Uran
FE2TI -- A Software for Large Scale Simulations of Sheet Metal Forming with Contact Using Computational Homogenization and Domain Decomposition Methods

20:30–21:00 Stephan Köhler
Globalization of Nonlinear FETI-DP Methods

21:00–21:30 Alexander Heinlein
FROSch Preconditioners for Land Ice Simulations of Greenland and Antarctica

21:30–22:00 Christian Hochmuth
Comparison of Monolithic and Block Preconditioners with GDSW-Type Coarse Spaces for Incompressible Fluid Flow Problems

MS12 – Asynchronous Iterative Methods

Organizers: Christian Glusa ◇ Daniel B. Szyld

Classical synchronous iterative methods alternate between local computation and boundary data exchange. In asynchronous iterative methods this dependency is relaxed and processing units are allowed to use whatever data is available at the beginning of a computation phase. Originally called 'Chaotic Relaxation' for fixed-point iterations, asynchronous iterative methods are used in various areas of high-performance computing and numerical optimization. In this minisymposium, recent research is presented both on the theory and implementation of asynchronous iterative methods.

Thursday 20:00–22:00

20:00–20:30 Damien Tromeur-Dervout
Acceleration of the Convergence of the Asynchronous Restricted Additive Schwarz Method

20:30–21:00 Christian Glusa
Asynchronous One- and Two-Level Domain Decomposition Solvers

21:00–21:30 Daniel B. Szyld
Algebraic View of Optimized Schwarz Methods

21:30–22:00 Faycal Chaouqui
Asynchronous Two-Level Optimized Schwarz Method

MS13 – Domain Decomposition Methods for Optimal Control Problems

Organizers: Gabriele Ciaramella

Optimal control and PDE-constrained optimization problems are of fundamental importance in several application areas. For these reasons, an intense research is boosting the development of efficient numerical strategies capable to deal with large-scale optimization and control problems. Among these strategies, domain decomposition methods (DDMs) represent one of the most powerful and probably the most versatile techniques for the efficient solution of large-scale problems emerging in different disciplines. On the one hand, DDMs are effective linear solvers and efficient preconditioners. On the other hand, the incredible versatility of DDMs has boosted their use for the efficient numerical treatment of heterogeneous multi-physics problems, problems in computational chemistry, optimization and optimal control problems.
In this minisymposium, recent advances of domain decomposition methods for the efficient solution of PDE-constrained optimization and control problems are presented. A particular focus will be put on time and space parallel methods, linear and non-linear preconditioning, and optimized transmission conditions. All these aspects and new research perspectives will be posed and discussed in light of the most recent developments.

Friday 20:00–22:00

20:00–20:30 Julien Salomon
A Time Parallelisation Method for Identification.

20:30–21:00 Luca Mechelli
Optimized Schwarz Method for Diffusion-Reaction PDE-Constrained Optimal Control Problems

21:00–21:30 Bérangère Delourme
Optimized Schwarz Methods for Complex Elliptic Problems

21:30–22:00 Gabriele Ciaramella
Nonlinear Precondtioners for a PDE-Constrained Optimization Problems

Saturday 20:00–21:00

20:00–20:30 Sebastian Reyes-Riffo
Time-Parallelization of Data Assimilation Problems

20:30–21:00 Huidong Yang
Space-Time Finite Element Solvers for Parabolic Optimal Control Problems

MS14 – Adaptive Coarse Spaces, Multipreconditioning and Reduced Basis Methods

Organizers: Martin J. Gander ◇ Axel Klawonn ◇ Oliver Rheinbach

In classical domain decomposition methods, coarse spaces are used to provide scalability. It was discovered however over the past decade that coarse spaces can do much more: they can make domain decomposition methods robust for problems with large contrasts in the coefficients, they can treat error components for which the underlying domain decomposition method is not effective, and they can even transform divergent domain decomposition methods into convergent ones, without Krylov acceleration. These new coarse spaces use techniques from multiscale finite elements, and are also related to reduced basis methods and multi preconditioning. This minisymposium brings researchers working on these various aspects together to exchange the most recent ideas in this field.

Saturday 20:00–22:00

20:00–20:30 Jascha Knepper
Adaptive Coarse Spaces for Schwarz Methods Based on Decompositions of the Domain Decomposition Interface

20:30–21:00 Bo Song
Convergence Properties of New Coarse Spaces for the Additive Schwarz Method

21:00–21:30 Stephan Rave
Adaptive Reduced Basis Domain Decomposition Methods

21:30–22:00 Faycal Chaouqui
On Optimal Coarse Grid Correction for the Optimized Schwarz Method

MS15 – Domain Decomposition Methods for Uncertainty Quantification and Applications

Organizers: Xuemin Tu ◇ Qifeng Liao

Most numerical simulations of physical systems are with different sources of uncertainties, which include geometrical uncertainty, initial and boundary data uncertainty, model structural uncertainty, parametric uncertainty and so on. The computational methods to study the uncertainty propagation, interplay, and predictions are usually much more expensive than the original forward model simulations. Domain decomposition methods have made significant progress on the forward model simulations. In this mini-symposium, we present recent research in computational methods for uncertainty quantification based on the domain decomposition methods.

Thursday 20:00–21:30

20:00–20:30 Xuemin Tu
Domain Decomposition for Implicit Sampling Methods

20:30–21:00 Zhiwen Zhang
A Class of Conforming Multiscale Finite Element Method for Elliptic Problems with Multiscale Coefficients

21:00–21:30 Ke Li
D3M: A Deep Domain Decomposition Method for Partial Differential Equations

Friday 10:00–12:00

10:00–10:30 Zhizhang Wu
The Direct Method of Lines for Elliptic Problems in Star-Shaped Domains

10:30–11:00 Mengnan Li
A Model Reduction for Nonlinear Multiscale Parabolic Problems

11:00–11:30 Junda Xiong
Clustered Active-Subspace Based Gaussian Process Emulator for High-Dimensional and Complex Models

11:30–12:00 Qifeng Liao
Domain Decomposed Uncertainty Analysis Based on RealNVP

MS16 – Polygonal Finite Elements, DG, and Related Methods

Organizers: Eun-Jae Park ◇ Dong-wook Shin ◇ Lina Zhao

Recently, polygonal finite elements have received great attention. Polygonal and polyhedral meshes offer a very convenient framework for mesh generation, mesh refinements and coarsening, mesh deformations, fracture problems, composite materials, and topology optimizations.

This mini-symposium is about Polygonal finite elements, DG, and related methods. This includes fast numerical methods such as domain decomposition and multigrid. We hope that this MS is to bring together experts as wells as junior researchers to discuss new types of questions at the foundation and applications.

Thursday 16:00–18:00

16:00–16:30 Blanca Ayuso de Dios
Pointwise A-Posteriori Error Analysis for a Discontinuous Galerkin Approximation of an Elliptic Obstacle Problem

16:30–17:00 Paola F. Antonietti
Agglomeration-Based Solvers for High-Order Discontinuous Galerkin Methods on Polygonal and Polyhedral Grids

17:00–17:30 Lina Zhao
An Analysis of Staggered DG Method for Coupling of the Stokes and Darcy-Forchheimer Problems

17:30–18:00 Dohyun Kim
Staggered Discontinuous Galerkin Methods for the Stokes Equations on General Polygonal Meshes

Friday 10:00–12:00

10:00–10:30 Junping Wang
Primal-Dual Weak Galerkin Finite Element Methods

10:30–11:00 Mi-Young Kim
A High Order Discontinuous Galerkin Method with Skeletal Multipliers for Convection-Diffusion-Reaction Problems

11:00–11:30 Eun-Hee Park
A FETI-DP Formulation for the Stokes Problem with a Discontinuous Viscosity

11:30–12:00 Dong-wook Shin
A Hybrid Difference Method for the Second-Order Elliptic Problems

MS17 – Nonlinear Preconditioning and Applications

Organizers: Xiao-Chuan Cai ◇ Martin J. Gander

Preconditioning is an established field of research in the case of linear problems, and there is even a conference dedicated to this topic: Preconditioning 2019 was the 11th in the series last year in Minnessotta. Preconditioning of nonlinear problems is however much less explored. Since the introduction of ASPIN (Additive Schwarz Preconditioned Inexact Newton), more and more people started to investigate nonlinear preconditioning techniques. The goal of this minisymposium is to bring together researchers in this field and to obtain an overview of the most recent developments of the algorithms and applications.

Thursday 16:00–18:00

16:00–16:30 Xiao-Chuan Cai
Nonlinear Preconditioning Strategies for CFD

16:30–17:00 Conor McCoid
Cycles in Newton-Raphson-Accelerated Alternating Schwarz

17:00–17:30 Martin Lanser
Additive and Hybrid Nonlinear Two-Level Schwarz Methods and Energy Minimizing Coarse Spaces for Unstructured Grids

17:30–18:00 Lulu Liu
Error Bounds on Solutions of PDEs

Friday 16:00–18:00

16:00–16:30 Axel Klawonn
Nonlinear FETI-DP - Tailoring the Nonlinear Elimination Set

16:30–17:00 Yaguang Gu
Minisymposium MS17: On the Choice of Robin Parameters for the Optimized RASPEN Method

17:00–17:30 Feng-Nan Hwang
Nonlinear Preconditioned Semismooth Newton Algorithms for Nonsmooth Systems

17:30–18:00 Pratik M. Kumbhar
Substructured Nonlinear Preconditioning

Saturday 20:00–22:00

20:00–20:30 David Keyes
A Nonlinearly Preconditioned Inexact Newton Method Based on Nonlinear Elimination

20:30–21:00 Li Luo
A Multi-Layer Nonlinear Elimination Preconditioned Inexact Newton Method for a Steady-State Incompressible Flow in 3D

21:00–21:30 Hardik Kothari
A True Matrix-Free Multigrid Preconditioner for Globalized Jacobian-Free Newton-Krylov Methods

21:30–22:00 Haijian Yang
A Parallel and Fully Implicit Constraint-Preserving Simulator for Multiphase Flow in Porous Media

MS18 – Average Schwarz Method and Numerical Homogenization: Theory and Implementation

Organizers: Guanglian Li ◇ Leszek Marcinkowski ◇ Talal Rahman

Additive Average Schwarz method was proposed by Bjørstadt, Dryja, Vainniko in early 90ties. The method is one of the simplest of all additive Schwarz preconditioners because it is easy to construct and quite straightforward to analyze. Unlike most additive Schwarz preconditioners, its local subspaces are defined on non-overlapping subdomains, and it requires no explicit coarse grid as its coarse space is simply defined as the range of an averaging operator. A closely related type of methods is the numerical homogenization methods, which have been studies for over half century in different research fields aiming at solving challenging multiscale problems efficiently. They have been applied to many practical applications successfully, including reservoir simulation, porous media and material science. The construction of coarse space or multiscale space plays a key role in several numerical homogenization methods, e.g., (Generalized) Multiscale Finite Element Methods (GMsFEMs) and Localized Orthogonal Decomposition (LOD) Methods.
The goal of this minisymposium is to present recent theoretical results and implementation issues on Average Schwarz method and Numerical Homogenization, and to arise attention of both communities on the theoretical development of each other.

Tuesday 20:00–22:00

20:00–20:30 Salah Alrabeei
Additive Average Schwarz with Enriched Coarse Space for Nonconforming Finite Elements

20:30–21:00 Daniel Peterseim
Localized Eigenstates by Domain Decomposition

21:00–21:30 Guanglian Li
Wavelet-Based Edge Multiscale Finite Element Method for Helmholtz Problems in Perforated Domains

21:30–22:00 Sai-Mang Pun
Computational Multiscale Methods and Numerical Homogenization

Wednesday 20:00–22:00

20:00–20:30 Frederic Legoll
A MsFEM Approach with High-Order Legendre Polynomials

20:30–21:00 Leszek Marcinkowski
Adaptive Average Schwarz Method for Crouzeix-Raviart Discretization of Multiscale Elliptic Problem

21:00–21:30 Yi Yu
Spectral Additive Schwarz Methods for Hybrid Discontinuous Garlerkin Discretizations

21:30–22:00 Juan Galvis
CR, P1 and Iterative Methods for Heterogeneous Problems

Thursday 20:00–22:00

20:00–20:30 Carlos Borges
Domain Decomposition Preconditioning for the Integral Equation Formulations of the Forward and Inverse Scattering Problems

20:30–21:00 Talal Rahman
Implementation Issues of Average Schwarz Method

21:00–21:30 Siamak Faal
FEM Solver for Cahn-Hilliard Equation

21:30–22:00 Petter E. Bjørstad
25 Years with Additive Average - a Brief Review

MS19 – Solution Techniques for Nonstandard Discretization Methods: Theory and Applications

Organizers: Blanca Ayuso de Dios ◇ Susanne C. Brenner

The aim of the session is to bring together experts who are active in the construction and analysis of solution techniques for non-standard discretizations. This includes the development of domain decomposition and multilevel type preconditioners, and also the design of adaptivity techniques.
Over the last decade, there has been un upsurge on the development of novel, "non standard" discretizations for complex partial differential equations (PDEs) featuring for instance multiple fields and/or multiple scales, due to many applications in material science, cell biology and continuum mechanics. In some instances it is essential to build structure preserving discretizations, while in others the complexity of the problem itself precludes the use of conventional discretizations. Among the advanced and innovative methods, one finds various discontinuous Galerkin methods, nonconforming approximations, isogeometric analysis, unfitted approaches or virtual element methods, to mention a few.
This mini-symposia will bring together experts in the different topics in the field to facilitate the discussion in identifying common points in the design of solution techniques for non-standard methods. Sample topics include the design, the theoretical analysis and issues related to the implementation and applications of the various solution techniques.

Thursday 19:30–22:00

19:30–20:00 Ana Alonso Rodríguez
On the Computation of the Eigenvalues of the **curl** Operator

20:00–20:30 Lukas Kogler
Auxiliary Space Preconditioning for Elasticity

20:30–21:00 Kening Wang
Additive Schwarz Preconditioners for C^0 Interior Penalty Methods for the Obstacle Problem of Clamped Kirchhoff Plates

21:00–21:30 Yuwen Li
A Unified Framework of A Posteriori Error Estimates by Preconditioning

21:30–22:00 Jose Garay
Additive Schwarz Preconditioners for a Localized Orthogonal Decomposition Method.

MS20 – Cross Points in Domain Decomposition Methods

Organizers: Kévin Santugini-Repiquet ◇ Laurence Halpern

In contrast to multigrid methods, domain decomposition methods with their aggressive coarsening strategy lead to cross points where more than two subdomains meet. The treatment of cross points in iterative domain decomposition methods is non-trivial, and often domain decomposition preconditioners diverge at cross points when used as stationary iterations, which leads for example to the coloring constant in the condition number estimate of Additive Schwarz, or the logarithmic term in the condition number estimate of FETI and Neumann-Neumann methods. We are interested in bringing together people who have worked on improving the cross point treatment in domain decomposition methods, and to get an up to date view of what the state of the art currently is.

Thursday 20:00–22:00

20:00–20:30 Yassine Boubendir
Non-Overlapping Domain Decomposition Methods for the Cross-Points Problem Using Nodal Finite Elements in the Approximation of the Helmholtz Equation

20:30–21:00 Xavier Claeys
Generalized Optimised Schwarz Method for Arbitrary Non-Overlapping Sub-Domain Partitions

21:00–21:30 Martin J. Gander
A Simple Finite Difference Discretization for Ventcell Transmission Conditions at Cross Points

21:30–22:00 Stella Krell
Optimized Schwarz Algorithms for DDFV Discretization

Friday 20:00–22:00

20:00–20:30 Axel Modave
A Non-Overlapping Domain Decomposition Method with High-Order Transmission Conditions and Crosspoint Treatment for Helmholtz Problems

20:30–21:00 Anouk Nicolopoulos
Corners and DDM for the Helmholtz Problem

21:00–21:30 Emile Parolin
Novel Non-Local Impedance Operators for Non-Overlapping DDM Applied to Wave Propagation Problems

21:30–22:00 Clemens Pechstein
A Unified Convergence Theory for Robin-Schwarz Methods - Continuous and Discrete, Including Crosspoints

Saturday 21:00–22:00

21:00–21:30 Anthony Royer
A Non-Overlapping Domain Decomposition Method with Perfectly Matched Layer Transmission Conditions

21:30–22:00 Stephan B. Lunowa
Asymptotic Preserving Cell-Centered Finite Difference Discretizations of Robin Transmission Conditions for Singularly Perturbed Elliptic Equations

MS21 – Domain-Decomposition Methods for Coupled Problems in Fluid Dynamics

Organizers: Anyastassia Seboldt ◇ Martina Bukač

Many applications from geomechanics, aerodynamics and biomedical engineering require the accurate and stable simulation of complex multiphysics processes. Examples include fluid-structure interaction models (e.g., valvular modeling), fluid-porous or poroelastic medium interaction models (e.g, groundwater flow, fracture propagation), as well as the transport problems (e.g., transport of drugs or chemicals). The numerical simulation of coupled problems has received considerable attention in recent years, but still remains a significant challenge in the mathematical and computational sciences. Substantial effort is allocated to the design of adaptable and robust numerical methods for coupled problems due to their intricate multiphysics nature and often strong nonlinearity. This minisymposium focuses on the domain decomposition methods and computational techniques used for solving coupled problems in various applications. Possible topics include but are not limited to: Fluid-structure interaction; Porous and poroelastic medium flow; Numerical analysis of domain decomposition methods; Validation and verification of numerical solvers; Higher-order partitioned methods for coupled problems.

Friday 10:00–12:00

10:00–10:30 Hyesuk Lee
Nonconforming Time Discretization Based on Optimized Schwarz Waveform Relaxation for the Stokes-Darcy System

10:30–11:00 Jeffrey Banks
Stable and Accurate Partitioned Methods for Fluid Structure Interaction

11:00–11:30 Thi-Thao-Phuong Hoang
A Global-In-Time Domain Decomposition Method for the Coupled Nonlinear Stokes and Darcy Flows

11:30–12:00 K. Chad Sockwell
Interface Flux Recovery Coupling Method for the Ocean-AtmosphereSystem

Friday 20:00–22:00

20:00–20:30 Thomas Wick
Parallel Block-Preconditioned Monolithic Solvers for Fluid-Structure-Interaction Problems

20:30–21:00 Rebecca Durst
Fully Discrete Loosely Coupled Robin-Robin Scheme for Incompressible Fluid-Structure Interaction: Stability and Error Analysis

21:00–21:30 Catalin Trenchea
Refactorization of the Midpoint Rule

21:30–22:00 Guosheng Fu
Monolithic Divergence-Conforing HDG Scheme for FSI: Linear Model and Efficient Block Preconditioning

MS22 – Robust Solvers for Multiphysics Problems

Organizers: Xiaozhe Hu ◇ Carmen Rodrigo

The simulation of multi-physics problems, where different models interact to describe a complex process, has recently received a lot of attention. These problems are often modeled by coupled systems of partial differential equations. Advances in the improved understanding of the modeling of such physical processes are crucial. However, mathematical modeling at appropriate scales is impossible without further developments in numerical approximations, and large-scale computational algorithms. The design of efficient solvers is an essential aspect in the numerical simulation of multi-physics problems, since an efficient and accurate solution method is crucial to carry out large-scale simulations, necessary to obtain realistic results and to deal with real-life applications. The focus of the minisymposium is on the design and practical implementation of robust solvers for multiphysics problems.

Saturday 20:00–22:00

20:00–20:30 Wietse M. Boon
Robust Preconditioners for Perturbed Saddle-Point Problems: Application to the Four-Field Biot Equations

20:30–21:00 Chunyan Niu
A Stabilized Hybrid Mixed Finite Element Method and Robust Preconditioners for Poroelasticity

21:00–21:30 Casey Cavanaugh
A Finite-Element Framework for a Mimetic Finite-Difference Discretization of Maxwell's Equations

21:30–22:00 Peter Ohm
Monolithic Multigrid for a Reduced-Quadrature Discretization of Poroelasticity

Contributed Sessions

CT01 – Tuesday 10:00–12:00

10:00–10:30 Alireza Yazdani
Convergence Study of The Closest Point Method Coupled with The Classical Schwarz Method

10:30–11:00 Kang-Li Xu
Optimal Model Order Reduction on Riemannian Manifolds of Port-Hamiltonian Systems

11:00–11:30 Lishan Fang
Error Indicators and Adaptive Refinement of Finite Element Thin-Plate Splines

11:30–12:00 Mingchao Cai
Numerical Algorithms for Biot Model and Applications in Brain Edema Simulation

CT02 – Wednesday 16:00–18:00

16:00–16:30 Abhijit Sarkar
Domain Decomposition of Time-Dependent Stochastic PDEs

16:30–17:00 Hyea Hyun Kim
Domain Decomposition Algorithms for Physics-Informed Neural Networks

17:00–17:30 Yannis El Gharbi
A Two-Level Substructuring Method Tailored to Schur Based Domain Decomposition Methods

17:30–18:00 Ralf Kornhuber
Numerical Homogenization of Fractal Interface Problems

CT03 – Thursday 16:00–17:30

16:00–16:30 Sebastian Kinnewig
Developing an Adaptive Finite Element Solver for the High Frequency Time-Harmonic Maxwell Equation

16:30–17:00 L. Robert Hocking
Optimal Complex Damping Parameters Minimizing Red-Black SOR Multigrid Smoothing Factors for Complex-Shifted Linear Systems

17:00–17:30 Piotr Krzyzanowski
Domain Decomposition Preconditioner for a Thin Membrane Diffusion Problem

CT04 – Friday 16:00–18:00

16:00–16:30 Jonas Thies
Exploiting Morton Curves for Domain Decomposition of Staggered Grid Discretizations in CFD

16:30–17:00 Ngoc Mai Monica Huynh
Scalable Newton-Krylov Solvers for Cardiac Reaction-Diffusion Models

17:00–17:30 François Madiot
Domain Decomposition Method for Nuclear Core Reactor Simulations with Low-Regularity Solution

17:30–18:00 Héléna Shourick
Aitken-Schwarz DDM for Hybrid EMT-TS Electrical Network Simulation

CT05 – Friday 20:00–22:00

20:00–20:30 Andrés Arrarás
Parallel Space--Time Methods for Evolutionary Reaction--Diffusion Problems

20:30–21:00 Jarle Sogn
Robust Preconditioning: Optimal Control of the Convection-Diffusion Equation with Limited Observation

21:00–21:30 Khaled Mohammad
Fully Discrete Schwarz Waveform Relaxation Analysis for the Heat Equation on a Bounded Domain

CT06 – Saturday 20:00–22:00

20:00–20:30 Jongho Park
Accelerated Additive Schwarz Methods for Convex Optimization

20:30–21:00 Karim Rhofir
On Asynchronous Multi-Subdomain Methods for Parabolic Problems

21:00–21:30 Michel Schanen
Domain Decomposition for Unstructured Nonlinear Programming on Parallel Vector Architectures

21:30–22:00 Igor Baratta
Automating Domain Decomposition Preconditioners with Code Generation