Accepted Minisymposium

Contents

[OS011] High-order methods for complexes

- **Abstract** : Complexes of function spaces naturally arise in a wide variety of physical applications, from fluid flow and electromagnetism, to general relativity. Compatible discretizations of these complexes not only preserve the underlying structure of the problem, but also often lead to stable methods. However, constructing compatible discretizations is a nontrivial task, and high order methods are often needed to avoid spurious behaviour or unnatural restrictions on the method, such as the need to use meshes with specific structure. In this minisymposium, we will focus on recent advancements of high order methods for a variety of complexes. Presentations will include the development of new methods, the analysis of new and existing methods, implementation aspects such as efficient algorithms and preconditioning, and applications.
- **Organizers** : Charles Parker (University of Oxford), Pablo Brubeck (University of Oxford)
- **Speakers Info** :
  - Mark Ainsworth (Brown University)
  - Will Pazner (Portland State University and Lawrence Berkeley National Laboratory)
  - **Charles Parker** (University of Oxford)
  - **Pablo Brubeck** (University of Oxford)
  - Jens Markus Melenk (Vienna University of Technology)
  - Théophile Chaumont-Frelet (Inria project-team Atlantis)
  - Qian Zhang (Michigan Technological University)
  - Evan Gawlik (University of Hawaii at Manoa)

[OS013] High order methods for gradient flows

- **Abstract** : The gradient flow is a powerful method to model various problems. Typical applications include phase field modeling in moving boundary problems appearing in Materials Science and Engineering. Its application covers from solidification of pure materials to crystal Modeling. Interfacial dynamics in complex fluids presents tremendous challenges to science. From a fluid mechanical viewpoint, the essential physics is the coupling between interfacial movement and the flow of the bulk fluids. Phase field (diffuse-interface) methods start from a multi-scale point of view and treat the interface as a microscopic transition zone of small but finite width. Then a set of governing equations can be derived that are thermodynamically consistent and mathematically well-posed. This principle is very powerful and flexible. It has been applied successfully to describe complicated interfaces in various complex fluids. Well designed numerical methods with the diffuse-interface approach can be highly robust and accurate, as long as the interface is well resolved. Phase field methods are now widely used in many branches of science and engineering, such as the material science, biomedical science, biology, chemical engineering. This mini-symposium will bring together numerical analysts and computational scientists working on high order numerical methods for phase field models. The main purposes of this mini-symposium are to review the current status, identify problems and future directions, and to promote phase field methods to a wider scientific and engineering community.
- **Organizers** : Chuanju Xu (Xiamen University)
- **Speakers Info** :
  - **Chuanju Xu** (Xiamen University)
  - Mejdi Azaiez (Bordeaux INP)
  - Xiaoli Li (Shandong University)
  - Qiaolin He (Sichuan University)
  - Zhonghua Qiao (HK polytechnic University)
  - Steven Dong (Purdue University)
  - Ping Lin (Dundee University)
  - Xiaoming Wang (Missouri S&T)
  - Jiang Yang (Southern University of Science and Technology)

[OS014] Advances in integral equation methods and applications

- **Abstract** : The recent advances in integral equations and their fast numerical methods have provided useful tools for many applications ranging from nano-optics to medical imaging and geosciences. This mini-symposium will discuss challenges in the formulation of the problem, cutting-edge fast algorithms and their efficient implementation, and their applications in various fields. At the same time, it will provide opportunities to promote interdisciplinary research collaboration between computational scientists and other fields.
- **Organizers** : Min Hyung Cho (University of Massachusetts Lowell), Adrianna Gillman (University of Colorado Boulder)
- **Speakers Info** :
  - Jingfang Huang (University of North Carolina at Chapel Hill)
  - Manas Rachh (Flatiron Institute/Simons Foundation)
  - **Adrianna Gillman** (University of Colorado Boulder)
  - Bowei Wu (University of Massachusetts Lowell)
  - Yabin Zhang (Westlake University)
  - **Min Hyung Cho** (University of Massachusetts Lowell)
  - James Bremer (University of Toronto)
  - Andreas Kloeckner (University of Illinois at Urbana-Champaign)

[OS015] Numerical methods and analysis for dispersive PDEs

- **Abstract** : Dispersive partial differential equations (PDEs) play a fundamental role in many fields such as the nonlinear optics, water wave theory, quantum mechanics, etc. From the perspective of computational mathematics, it is significant to design efficient numerical methods to solve dispersive PDEs with in-depth numerical analysis and provide an intuitive view for physical phenomena. The proposed minisymposium invites experts in this field to review recent advances in numerical methods and analysis for dispersive PDEs.
- **Organizers** : Yue Feng (Sorbonne Université), Weizhu Bao (National University of Singapore)
- **Speakers Info** :
  - **Weizhu Bao** (National University of Singapore)
  - Yvonne Alama Bronsard (Sorbonne Université)
  - Lukas Einkemmer (University of Innsbruck)
  - **Yue Feng** (Sorbonne Université)
  - Georg Maierhofer (Sorbonne Université)
  - Alexander Ostermann (University of Innsbruck)
  - Chunmei Su (Tsinghua University)
  - Chushan Wang (National University of Singapore)

[OS016] Space-time Spectral Methods

- **Abstract** : Most common spectral methods for time dependent PDEs use low-order finite difference discretizations of the time derivative and spectral discretizations of the spatial derivatives. This is not ideal because of the imbalance in the temporal and spatial discretization errors. Space-time spectral methods apply spectral discretizations in both space and time, resulting in spectral convergence whenever the solution is analytic. Unfortunately time-stepping is no longer possible for space-time spectral methods as all unknowns over all times must be solved simultaneously. New mathematical tools must be developed to analyze the convergence and complexity of space-time spectral methods. Furthermore, new algorithms, including parallel algorithms, are needed to expedite the solution of large systems arising in space-time spectral methods. A particularly important class includes parallel-in-time (PinT) methods.

- **Organizers** : Shaun Lui (University of Manitoba)
- **Speakers Info** :
  - Jie Shen and Li-Lian Wang (Purdue University and Nanyang Technological University)
  - Changtao Sheng (Shanghai University of Finance and Economics)
  - Shu-Lin Wu (Northeast Normal Univeristy)
  - **Shaun Lui** (University of Manitoba)

[OS017] Towards Practical High-Order Methods for Unsteady High-Fidelity Computational Fluid Dynamics

- **Abstract** : The use of computational fluid dynamics algorithms has become ubiquitous in science and engineering. While modern and future computational architectures promise unprecedented power to push the boundaries of basic science and engineering design and optimization for problems in fluid dynamics, their efficient utilization is a highly active area of research. Because of their dense compute kernels, high-order methods are a natural choice for unsteady problems requiring tight error tolerances. However, most fluid dynamics problems of interest are nonlinear and occur on complex geometries, and for such problems high-order methods have traditionally suffered from stability issues making them impractical. Nevertheless, in the last decade there has been a dedicated push to resolve this issue through the construction of schemes with provable properties (e.g., entropy-stable, positivity preserving etc) as well as a number of sophisticated algorithms to mitigate stability issues. Furthermore, there has been an equally dedicated push to develop technologies to make high-order methods efficient on modern compute systems. In this minisymposium, the focus is on the mathematics that enable the use of high-order methods for practical fluids problems. Topics that are of interest include but are not limited to provably stable schemes, time stepping, stabilization, adaptation, space-time methods, unstructured schemes, and mechanics for the efficient deployment of high-order methods on modern and future compute architectures.
- **Organizers** : Brian Vermeire (Concordia University), David Del Rey Fernandez (The University of Waterloo), Siva Nadarajah (McGill University)
- **Speakers Info** :
  - **Brian Vermeire** (Concordia University)
  - **Siva Nadarajah** (McGill University)
  - Dongze Li (The University of Waterloo)
  - Matteo Parsani (King Abdullah University of Science and Technology)
  - Gianmarco Mengaldo (National University of Singapore)
  - Takanori Haga (Japanese Aerospace Exploration Agency)
  - Chongnam Kim (Seoul National University)
  - Andrés M.Rueda-Ramírez (University of Cologne)

[OS018] High Order Mimetic Methods and Applications

- **Abstract** : Mimetic Methods have been used more and more recently very effectively. In this session we present recent advances of mimetic methods including energy conservation and numerical stability results as well and combination with other methods for shock capturing schemes.
- **Organizers** : Jose E Castillo (San Diego State University)
- **Speakers Info** :
  - **Jose E. Castillo** (Computational Science Research Center at San Diego State University)
  - Dinshaw Balsara (Department of Physics and Astronomy, Notre Dame University)
  - Wai-Sun Don (School of Mathematical Sciences, Ocean University of China)
  - Jeffrey Shragge (Geophysics Department, Colorado School of Mines)

[OS019] Recent Advances in High-Order Discontinuous Finite Element Methods

- **Abstract** : Complex multiphysics systems appear in many important real-life applications, such as multiphase flows, computational geosciences, magnetohydrodynamics, fluid-structure interactions, etc. These highly-nonlinear problems describe strongly coupled physical mechanisms that interact on a wide range of length- and time-scales and require robust and efficient high-resolution numerical approximations. For this reason, developing robust, and accurate methods that can effectively use parallel computation at extreme scales is critical. In this context, numerical discretizations and solvers for practical multiphysics simulations must be: (1) High-order accurate in space and time; (2) Stable; (3) Conservative; (4) Having minimum degrees of freedom for implicit solution approaches; (5) Well suited for unstructured meshes; (6) Well suited for hp-adaptivity; (7) Well suited for applications with disparate temporal and spatial scales; and (8) Well suited for fine-grain parallelism. This minisymposium focuses on the latest developments in high(er) order discontinuous finite element, and related methods and associated numerical methods. The speakers in this minisymposium will address theoretical/numerical and computational issues critical to developing approaches with these desired properties. Applications will include aerodynamics, magnetohydrodynamics, plasma physics, subsurface flows, geophysical flows, etc.
- **Organizers** : Tamas Horvath (Oakland University), Tan Bui-Thanh (The University of Texas at Austin), Shinhoo Kang (Argonne National Laboratory), Jau-Uei Chen (The University of Texas at Austin)
- **Speakers Info** :
  - Krzysztof Fidkowski (University of Michigan)
  - Logan Larose (Pennsylvania State University)
  - Per-Olof Persson (University of California Berkeley)
  - Misun Min (Argonne National Laboratory)
  - Wonjong Kim (Yonsei University)
  - Soonpil Kang (Naval Postgraduate School)
  - Sehun Chun (Yonsei University)
  - Zubin Lal (University of Minnesota)
  - Eric Chung (The Chinese University of Hong Kong)
  - **Jau-Uei Chen** (The University of Texas at Austin)
  - **Shinhoo Kang** (Argonne National Laboratory)
  - **Tamas Horvath** (Oakland University)

[OS020] Recent advances of novel high order accurate methods for conservation laws

- **Abstract** : Conservation laws equations are fundamental in mathematics and physics, with applications ranging from fluid dynamics to electromagnetism. Despite their importance, the numerical solution of conservation laws can be challenging due to the presence of discontinuities and the need for high accuracy. In recent years, there has been a significant push towards the development of novel high-order accurate methods for the solution of conservation laws. This minisymposia aims to bring together researchers working on the development and analysis of high order accurate methods for conservation laws. The goal of the minisymposia is to present the latest advances in this field and to foster discussions on open problems and future directions.
- **Organizers** : Xiangxiong Zhang (Purdue University), Chi-Wang Shu (Brown University)
- **Speakers Info** :
  - Yulong Xing (Ohio State University)
  - Zhengfu Xu (Michigan Tech University)
  - Yuan Liu (Wichita State University)
  - Fengyan Li (Rensselaer Polytechnic Institute)

- Jue Yan (Iowa State University, USA)
- Wei Guo (Texas Tech University)
- Zheng Chen (University of Massachusetts at Dartmouth)
- **Xiangxiong Zhang** (Purdue University)

[OS021] Computational Methods for Plasmonics and Optics: Diverse Approaches to High Order Methods

- **Abstract** : The scattering of electromagnetic waves by irregular obstacles, periodic gratings, and other geometrically complex structures arises in a wide array of scientific and engineering applications. In fact, these models are at the heart of everyday technologies such as seismic imaging, underwater acoustics, and biological sensing. Clearly, there is a compelling need for algorithm design, rigorous analysis, and mathematical model development from applied mathematicians and computational scientists. Despite significant successes along these lines, some very important challenges remain. While low-order numerical methods play a significant role in the simulation of these devices, High Order approaches are becoming increasingly important to theoreticians and practitioners. Interestingly, many paths have been taken to achieve high accuracy in this setting including Spectral, Integral Equation, Spectral Element, hp Continuous and Discontinuous Galerkin, and High-Order Perturbation of Surfaces methods. Very recently, machine learning and deep learning have been further extended to complex electromagnetic problems, such as structural design and optimal parameter extraction, and data interpretation for radar. The main purpose of this workshop is to bring together experts in all of these approaches with the goal of not only communicating the state-of-the-art in these fields but also identifying areas of future collaboration.
- **Organizers** : Youngjoon Hong (Sungkyunkwan University), David Nicholls (University of Illinois, Chicago)
- **Speakers Info** :
  - **David Nicholls** (University of Illinois, Chicago)
  - **Youngjoon Hong** (Sungkyunkwan University)
  - Yiqi Gu (University of Hong Kong)
  - Oscar Bruno (Caltech)
  - Matthias Maier (Texas A&M University)
  - Peter Monk (University of Delaware)
  - Gang Bao (Zhejiang University)
  - Fadil Santosa (University of Minnesota)

[OS022] Hybrid High-Order Methods

- **Abstract** : The hybrid high-order (HHO) methodology provides postmodern hDG finite element schemes, those are nonconforming schems of any order on polytops. The HHO minisymposium provides a plattform for recent devellopments in the area: Applications to fourth-oder or dynamic PDEs and adaptivity and the direct computation of guaranteed lower eigenvalue bounds.
- **Organizers** : Carsten Carstensen (Humboldt)
- **Speakers Info** :
  - Zhaonan Dong (Inria)
  - Morgane Steins (ENCP)
  - Benedikt Gräßle (Humboldt)
  - Emilie Pirch (U Jena)

[OS023] Recent Advances in Non-Traditional Spectral Methods

- **Abstract** : Spectral methods have achieved great success over the past four decades in traditional numerical PDE fields with smooth solutions such as fluid mechanics. In recent years, more and more efforts have been paid to spectral methods for various integral equations, fractional differential equations, nonlocal model equations, and PDE/IE eigenvalue problems; Diverse non-traditional spectral methods have been proposed for more challenging problems with either high-dimensionality, unbounded domain, strong/full nonlinearity, strong singularity, high oscillation. With a great variety of non-polynomial basis functions and approximation schemes coming into existence, the adaptability and application range of non-traditional spectral methods have been continuously expanded, and the superiority of the non-traditional spectral methods in both accuracy and efficiency over other numerical methods has been verified.
  The aim of this mini-symposium is to bring together scholars in related research fields to share their recent advances in non-traditional spectral methods, and to discuss the common basic issues of non-traditional spectral methods for challenge problems.
- **Organizers** : Huiyuan Li (Institute of Software, Chinese Academy of Sciences), Zhongqing Wang (University of Shanghai for Science and Technology), Lijun Yi (Shanghai Normal University)
- **Speakers Info** :
  - Jing An (Guizhou Normal University)
  - Haotao Cai (Shandong University of Finance and Economics)
  - Waixiang Cao (Beijing Normal University)
  - Yanping Chen (South China Normal University)
  - Yuling Guo (University of Shanghai for Science and Technology)
  - Qiumei Huang (Beijing University of Technology)
  - Wenjie Liu (Harbin Institute of Technology)
  - Shan Li (University of Shanghai for Science and Technology)
  - Xiaoli Li (Shandong University)
  - Zhaoxiang Li (Shanghai Normal University)
  - Hui Liang (Harbin Institute of Technology, Shenzhen)
  - Zhiping Mao (Xiamen University)
  - Jiajia Pan (University of Shanghai for Science and Technology)
  - Yonghui Qin (Guilin University of Electronic Technology)
  - Tao Sun (Shanghai Lixin University of Accounting and Finance)
  - Haiyong Wang (Huazhong University of Science and Technology)
  - Tianjun Wang (Henan University of Science and Technology)
  - Yin Yang (Xiangtan University)
  - **Lijun Yi** (Shanghai Normal University)
  - Fanhai Zeng (Shandong University)
  - Jing Zhang (Central China Normal University)
  - Jun Zhang (Guizhou University of Finance and Economics)
  - Haiyan Yuan (Heilongjiang Institute of Technology)

[OS024] High-order methods for wave propagation problems

- **Abstract** : The numerical solution of wave propagation problems remains relevant and challenging in many application fields. Because of the oscillatory nature of the solutions, accurate numerical simulations require expensive computational procedures, and innovative strategies are required to ensure the accuracy, the efficiency and the robustness of both new and existing numerical methods. This minisymposium focuses on the design and the analysis of high-order methods specifically developed for solving wave propagation problems. Topics of interest encompass methods dealing with time-harmonic or time-dependent problems, scalar or vector waves, homogeneous or heterogeneous media, and accurate interface or boundary conditions.

- **Organizers** : Axel Modave (CNRS), Théophile Chaumont-Frelet (INRIA)
- **Speakers Info** :
  - Stefan Sauter (University of Zurich, Switzerland)
  - Seungil Kim (Kyung Hee University)
  - Joachim Schöberl (TU Wien)
  - **Axel Modave** (CNRS)
  - Patrick Vega (Pontifical Catholic University of Valparaíso)
  - Markus Melenk (TU Wien)
  - Sergio Gómez (University of Pavia)
  - Daniel Eckhardt (Karlsruher Institut für Technologie)

[OS025] High Order Methods for PDEs with Singular or Oscillatory Solutions

- **Abstract** : It is known that the accuracy and performance of a usual spectral method might be deleteriously degraded when the solution exhibits local singular behaviours with very limited regularity. In practice, the singularity may occur in various scenarios such as PDEs in non-smooth computational domains with sharp corners or with degenerate or discontinuous coefficients, non-matching boundary conditions, singular kernels or potentials, and non-differentiable nonlinear terms among others. On the other hand, high-order methods have proven to be the method of choice for PDEs with oscillatory solutions with wide applications in simulations of water waves in ocean dynamics, matter waves in quantum physics and soliton waves in optical fibers among others. Many of them can be described by PDEs such as nonlinear Scrodinger equation, Klein-Gordon equation, Korteweg–de Vries equation and Maxwell equation. Efficient and accurate numerical simulations for such PDEs are highly demanding in scientific and engineering computations. Spectral methods are capable of producing very accurate simulation results, and more importantly, they require a substantially smaller number of unknowns (even for engineering accuracy) when compared to their lower-order counterparts. Given these two classes of challenging problems, how to properly design spectral methods and conduct the related numerical analysis is a research topic of longstanding interest and worthy of deep investigation. This mini-symposium aims at bringing together numerical analysts and computational scientists to present their findings on recent advances in algorithm development and analysis of spectral methods for singular and/or oscillatory problems. The theme is to present some novel developments of spectral method and applications of spectral methods in solving these PDEs.
- **Organizers** : Li-Lian Wang (Nanyang Technological University), Yongyong Cai (Beijing Normal University)
- **Speakers Info** :
  - Weizhu Bao (National University of Singapore)
  - Sheng Chen (Beijing Normal University at Zhuhai)
  - Jie Shen (Purdue University)
  - Yujian Jiao (Shanghai Normal University)
  - Kai Jiang (Xiangtan University)
  - Karolina Kropielnicka (Institute of Mathematics, Polish Academy of Sciences)
  - Huiyuan Li (Institute of Software, Chinese Academy of Science)
  - Ling Guo (Shanghai Normal University)
  - Chunmei Su (Tsinghua University)
  - Shihong Shao (Peking University)
  - Bo Wang (Hunan Normal University)
  - Shuhuang Xiang (Central South China University)
  - Zhiguo Yang (Shanghai Jiaotong University)
  - Haijun Yu (Chinese Academy of Science)
  - Zhimin Zhang (Beijing Computational Science Research Center)
  - Lunji Song (Lanzhou University)

[OS026] High-order numerical methods and applications of gradient flows

- **Abstract** : Gradient flows are dynamics driven by a free energy. Many physical problems can be modeled by PDEs taking the form of gradient flows, which are often derived from the second law of thermodynamics. Examples of these problems include interface dynamics, crystallization, thin films, polymers, and liquid crystals, as well as many widely used phase-field models such as Allen-Cahn equations, Cahn-Hilliard equations thin film models, phase-field crystal models. Since these models are usually highly nonlinear and challenging to to solve, numerical methods play an important role in the applications. This mini-symposium is dedicated to high-order numerical methods for these gradient flows with particular emphasis on the phase-field models.
- **Organizers** : Jiang Yang (Southern University of Science and Technology), Jie Shen (Purdue University)
- **Speakers Info** :
  - **Jie Shen** (Purdue University)
  - Tao Tang (Beijing Normal University-Hong Kong Baptist University United International College)
  - Xiaoming Wang (Missouri University of Science and Technology)
  - Chuanju Xu (Xiamen University)
  - Zhonghua Qiao (The Hong Kong Polytechnic University)
  - Guanghui Hu (University of Macau)
  - Tao Zhou (Chinese Academy of Sciences)
  - **Jiang Yang** (Southern University of Science and Technology)
  - Buyang Li (The Hong Kong Polytechnic University)
  - Zhen Zhang (Southern University of Science and Technology)
  - Jilu Wang (Harbin Institute of Technology)
  - Chaoyu Quan (Southern University of Science and Technology)

[OS027] Numerical Methods for Problems in Continuum Mechanics and Related Applications

- **Abstract** : This session aims to bring together researchers working on the theoretical analysis and applications of mixed finite and virtual element methods. We will focus on novel discretizations for coupled partial differential equations (PDEs) arising in multiphysics models and featuring, for example, nonlinear effects, interfacial interactions, and eigenproblems. We will also discuss new analysis techniques in order to gain further insight into the behavior of these complex systems. The minisymposium will provide an opportunity for researchers to share their insights, knowledge, and experience of developing efficient numerical methods and algorithms for solving these challenging problems. We welcome contributions from all fields related to the theoretical analysis and applications of mixed finite and virtual elements, and we are particularly interested in potential new approaches and applications.
- **Organizers** : David Mora (Universidad del Bío-Bío), Ricardo Ruiz-Baier (Monash University)
- **Speakers Info** :
  - Gonzalo Rivera (Universidad de Los Lagos)
  - Felipe Lepe (Universidad del Bío-Bío)
  - Carlos Reales (Universidad de Córboba)
  - Verónica Anaya (Universidad del Bío-Bío)
  - **Ricardo Ruiz-Baier** (Monash University)
  - Rekha Khot (Monash University)
  - Jesus Vellojin (Universidad Federico Santa Maria)
  - **David Mora** (Universidad del Bío-Bío)

[OS028] Recent advances in boundary integral methods: algorithms, applications, and theory

- **Abstract** : Our goal is to bring together early career researchers focused on fast algorithms for integral equation methods. We are interested in covering a wide variety of application areas in order to encourage collaboration and the cross-pollination of ideas. To that end, we encourage presentations on different topics, including novel applications, algorithms, and theoretical developments.
- **Organizers** : Fredrik Fryklund (New York University), Samuel Potter (New York University)
- **Speakers Info** :
  - Thomas G. Anderson (University of Michigan)
  - Tristan Goodwill (New York University)
  - Sivaram Ambikasaran (Indian Institute of Technology Madras)
  - Shoken Kaneko (University of Maryland, College Park)
  - Joar Bagge (KTH Royal Institute of Technology)
  - Hai Zhu (Flatiron Institute)
  - **Samuel Potter** (New York University)
  - **Fredrik Fryklund** (New York University)

[OS029] Recent advances in high-order mesh generation and adaptation

- **Abstract** : High-order methods are attractive for numerical solution of partial differential equations because they enable accurate discretization of curvilinear surfaces in the domain of interest at a lower computational cost in comparison to low-order meshes. However, the generation of high-order meshes continues to present a significant challenge and often becomes a bottleneck for complex configurations. Additionally, problems featuring transient geometry and/or solution add another layer of complexity when no single mesh is sufficient to obtain an accurate solution at a reasonable computational cost. For these problems, high-order mesh adaptation techniques can help circumvent having to generate many meshes using $h-$, $r-$, and $p-$adaptivity. This minisympoium will provide a forum to discuss recent advances to the state-of-the-art for high-order mesh generation and adaptation. We propose a single-session minisympoium of 4 speakers, in which we will bring together leading experts from academia and industry. The proposed talks include topics of significant interest in challenging problem areas, including generation of meshes for industrialisation of high-order methods, mesh curving and techniques that can be used to enable adaptive simulations. Note: at the time of writing we are still to confirm a final talk for the session, but anticipate that 4 talks would be presented in this MS.
- **Organizers** : David Moxey (King's College London)
- **Speakers Info** :
  - Ketan Mittal (Lawrence Livermore National Laboratory)
  - Suzanne Shontz (University of Kansas)
  - **David Moxey** (King's College London)

[OS030] High Accuracy Methods for Complex Systems

- **Abstract** : Complex systems problems are intrinsically difficult to solve due to their wide range of scales, complicated component relationships and distinct properties arising from these relationships, such as nonlinearity and discontinuity. For these problems, a prediction method must have enough resolution to capture all active variations while maintaining the robustness and efficacy of the method. Furthermore, in incorporating such methods for inference problems, judicious treatment of data is crucial to achieving high accuracy due to the relatively small size of measurement data compared to the high dimension of the complex systems. This mini-symposium will bring together researchers working on high-order prediction methods and high-accuracy data analysis methods for complex systems, which aims to foster collaborations between the groups to investigate the high-order methods in the context of high-accuracy inference problems.

- **Organizers** : Yoonsang Lee (Dartmouth College), Tongtong Li (Dartmouth College)
- **Speakers Info** :
  - Fengyan Li (RPI)
  - Duk-soon Oh (CNU)
  - Yulong Xing (OSU)
  - Lu Zhang (Columbia University)
  - Max Ramgraber (MIT)
  - Mustafa Mohamad (Univ of Calgary)
  - **Tongtong Li** (Dartmouth College)
  - Minseok Choi (Postech)

[OS031] Recent developments in polytopal discretization methods

- **Abstract** : Polytopal discretization methods for the approximate solution of partial differential equations developed rapidly over the last decade. In this mini-symposium, we aim to gather researchers interested in some specific features of such methods: the construction of structure-preserving schemes for the approximate solution of partial differential equations and the analysis and design of adaptive algorithms as well as efficient solvers. On the one hand, adaptivity in polytopal methods automatically allows for hanging nodes and nonmatching interfaces, whereas agglomeration can be successfully exploited in designing efficient solvers. On the other hand, using polytopal elements simplifies the meshing when dealing with multiphysics and multiscale problems in complicated data. This mini-symposium aims to bring together leading researchers that have contributed to these different aspects of the development and application of polytopal methods and promote exchanges between them.
- **Organizers** : Lina Zhao (City University of Hong Kong), Zhaonan Dong (INRIA & CERMICS, Ecole des Ponts), André Harnist (INRIA & CERMICS, Ecole des Ponts)
- **Speakers Info** :
  - Michele Botti (Politecnico di Milano)
  - Lorenzo Mascotto (University of Milano-Bicocca)
  - Jerome Droniou (Monash University)
  - Emmanuil Georgoulis (Heriot-Watt University/ National Techinical University of Athens)
  - Jianguo Liu (Colorado State University)
  - Giuseppe Vacca (University of Bari)
  - Hyeokjoo Park (Korea Advanced Institute of Science and Technology)
  - **Lina Zhao** (City University of Hong Kong)
  - Minseok Choi (Postech)

[OS032] Recent developments in physical-property-preserving WENO schemes and DG methods for hyperbolic single- and multi-medium models

- **Abstract** : The weighted essentially-oscillatory (WENO) schemes and discontinuous Galerkin (DG) methods are very robust and stable for solving nonlinear hyperbolic problems containing strong shocks and maintaining high-order accuracy in smooth regions. They have become a very popular class of numerical methods for solving problems with discontinuities or sharp gradient regions and complex, smooth region structures. In this mini-symposium, we gather together researchers in the areas of high-order WENO schemes and DG methods for solving hyperbolic models. The mini-symposium will present recent progress in physical-property-preserving WENO methods and DG methods, including the well-balanced methods for hyperbolic balance laws, the bound-preserving methods for hyperbolic conservation laws, the equilibrium-preserving methods for hyperbolic multi-medium models, and so on. The speakers in this mini-symposium will describe their recent research, including algorithm formulation, analysis, and applications. The proposed mini-symposium will gain significant attention since it will provide a valuable opportunity for researchers from different areas to investigate the idea of

physical-property-preserving methods. This mini-symposium will offer an excellent opportunity for participants to meet and exchange ideas and discuss new challenges facing our community in computational mathematics and scientific computing.

- **Organizers** : Bao-Shan Wang (Ocean University of China), Wai Sun Don (Ocean University of China), Peng Li (Shijiazhuang Tiedao University)
- **Speakers Info** :
  - **Peng Li** (Shijiazhuang Tiedao University)
  - Yaguang Gu (South China University of Technology)
  - Pei Fu (Nanjing University of Aeronautics and Astronautics)
  - Qian Zhang (Harbin Institute of Technology)

[OS033] High-order CFD Methods and Software for High-performance Computing

- **Abstract** : High-order methods have great potential for efficiently resolving the multi-scale flow physics of complex engineering applications under strict accuracy requirements. However, the widespread uptake of high-order methods by the industry is being delayed due to several unresolved issues, such as stable methods for aliasing and shock-driven instabilities, flexible methods to handle complex unstructured meshes, scalable memory-efficient preconditioners, and high-performance compute kernel embracing modern computing devices. From this perspective, this mini-symposium aims to discuss recent advances in high-order CFD methods and software development for high-performance computing. The focus is on the mathematical and computational efforts to boost the levels of accuracy and efficiency of high-order methods. Topics include, but are not limited to, spatial discretization methods, time-stepping methods, shock-capturing methods, moving and overset meshes, hp-adaptation, multiphysics, and software development to conduct high-performance multi-scale computing for practical engineering applications. The mini-symposium will bring together researchers working on both fundamental and applied aspects of CFD to provide a forum for discussion, interaction, and assessment of recent advances.
- **Organizers** : Hojun You (Sejong University), Jin Seok Park (Inha University)
- **Speakers Info** :
  - Krzysztof Fidkowski (University of Michigan)
  - Jooyoung Hahn (Slovak University of Technology in Bratislava), Slovakia Finite Volume Method for Level Set Equations on Polyhedral Meshes
  - Md Badrul Hasan (University of Maryland)
  - H. T. Huynh (NASA Glenn Research Center
  - Kan Liu (University of Maryland)
  - David Moxey (King's College London)
  - Carl Ollivier-Gooch (The University of British Columbia)
  - **Jin Seok Park** (Inha University)
  - Z. J. Wang (The University of Kansas)
  - **Hojun You** (Sejong University)
  - Meilin Yu (University of Maryland)

[OS034] Scientific machine learning for the data-driven discovery of dynamical systems

- **Abstract** : Scientific Machine Learning (SciML) has emerged as an active research field of Artificial Intelligence (AI). The goal is to tackle challenging scientific and engineering problems on which traditional approaches are either ineffective or even not applicable. While advanced AI techniques provide new perspectives and computational tools for scientific computing, care must be taken as they are not

entirely reliable and often unstable for various unknown reasons. For predictive computational solutions, the AI approaches need to be revised or even newly re-developed from perspectives of applied and computational mathematics. This mini-symposium focuses on the recent progress of SciML for the data-driven discovery of dynamical systems and addresses some of the urgent challenges therein. The topics include but are not limited to, mathematical analysis (e.g. convergence, error estimates), optimization of neural networks (NNs), modeling of interactions via graph neural networks, structure-preserving NNs, and identification of dynamics from noisy data.

- **Organizers** : Yeonjong Shin (KAIST), Minseok Choi (POSTECH)
- **Speakers Info** :
  - Dongbin Xiu (The Ohio State University)
  - Sung-Ha Kang (Georgia Tech)
  - Nathaniel Trask (Sandia National Laboratories)
  - Qianxiao Li (National University of Singapore)
  - Mike Kirby (University of Utah)
  - Tan Bui (UT Austin)
  - Xueyu Zhu (University of Iowa)
  - Jae-Yong Lee (KIAS)

[OS035] Tensor networks and compositional functions for high-dimensional approximation

- **Abstract** : While high-dimensional functions are ubiquitous in modern science and engineering, their approximation remains a challenging task often plagued by the curse of dimensionality. To break this curse, modern tools increasingly rely on compositional representations such as feed-forward neural networks and tree tensor networks. Due to the high-dimensional nature of these models, their training is complex, and their quality depends heavily on the choice of the sample in the empirical risk minimisation. Obtaining provable error bounds and efficient, practical algorithms is currently the subject of active research and often relies on the regularity of the solution in the form of a known hierarchical decomposition, anisotropic or compositional sparsity. This mini-symposium aims at gathering experts to present recent advances in approximation and learning of high-dimensional functions.
- **Organizers** : Philipp Trunschke (Nantes Université), Martin Eigel (WIAS Berlin), Anthony Nouy (Nantes Université)
- **Speakers Info** :
  - **Martin Eigel** (WIAS Berlin)
  - **Philipp Trunschke** (Nantes Université)
  - Christoph Schwab (ETH Zurich)
  - Vladimir Kazeev (University of Vienna)
  - Helmut Harbrecht (University of Basel)
  - Jakob Zech (Heidelberg University)
  - Damiano Lombardi (INRIA)
  - Henrik Eisenmann (RWTH Aachen)

[OS036] High-Order Algorithms, Software and Applications for Exascale

- **Abstract** : This minisympoisum focuses on discussing high-order discretization kernels and lightweight portable libraries to achieve optimal performance of solvers on exascale hardware. Topics will include efficient next-generation discretizations of arbitrarily high order also on complicated geometries, the interplay between algorithm specialization for specific applications versus generality, algorithm and software development including their impact on the design of exascale architectures, as well as system and application software for improved portability and performance of high-order methods. High-order discretizations have the potential to provide an optimal strategy for achieving high performance and

delivering fast, efficient, and accurate simulations on next-generation architectures. This minisymposium will discuss next-generation high-order discretization algorithms, based on finite/spectral element approaches that will enable a wide range of important scientific applications to run efficiently on current and evolving computer architecture.

- **Organizers** : Misun Min (Argonne National Laboratory), Paul Fischer (University of Illinois Urbana-Champaign), Tzanio Kolev (Lawrence Livermore National Laboratory)
- **Speakers Info** :
  - **Paul Fischer** (University of Illinois Urbana-Champagin)
  - Elia Merzari (Penn State)
  - Will Pazner (Lawrence Livermore National Laboratory)
  - Pablo Brubeck Martinez (University of Oxford)
  - **Tzanio Kolev** (Lawrence Livermore National Laboratory)
  - Spencer Sherwin (Imperial College London)
  - Jeremy Luke Thompson (University of Colorado Boulder)
  - Milan Holec (Lawrence Livermore National Laboratory)

[OS037] Polygonal finite elements, DG and related methods

- **Abstract** : This minisymposium is concerned with construction and applications of Polygonal finite elements, DG, and related methods. General meshes offer a very convenient framework for mesh generation, mesh refinements and coarsening, mesh deformations, fracture problems, composite materials, topology optimizations. We hope that the minisymposium is to bring together experts as well as junior researchers with common interest but with various backgrounds and knowledge, to discuss physics-preserving schemes, polytopal meshes and high-order methods. The mini-symposium will also deal with the applications to fluid dynamics and interface problems.
- **Organizers** : Eun-Jae Park (Yonsei University), Ruchi Guo (UC Irvine), Dongwook Shin (Ajou University)
- **Speakers Info** :
  - Carsten Carstensen (Humboldt University of Berlin)
  - Lina Zhao (City University of Hong Kong)
  - Hyea Hyun Kim (Kyung Hee University)
  - Jeonghun Lee (Baylor University)
  - Do Y. Kwak (Korea Advanced Institute of Science and Technology)
  - Chunyu Chen (Xiangtan University)
  - **Ruchi Guo** (University of California, Irvine)
  - **Dongwook Shin** (Ajou University)
  - Shubin Fu (Eastern Institute for Advanced Study)
  - **Eun-Jae Park** (Yonsei University)
  - Yongmok Jeon (Ajou University)