



2022 AFOSR Computational Mathematics Review

Dr. Fariba Fahroo | August 15-19, 2022 | Arlington, VA -hybrid

Agenda Day 1 | Monday- August 15, 2022

All times are EDT

Time	Topic	Speaker
8:15-8:45	Zoom Login	
8:45-9:00	Welcome – Opening Remarks	Dr. Fariba Fahroo, AFOSR
9:00	(YIP) Bayesian Learning of Dynamical Systems Under Uncertainty	Alex Gorodetsky (University of Michigan)
9:25	MURI- Prediction, Statistical Quantification and Mitigation of Extreme Events Caused by Exogenous Causes or Intrinsic Instabilities	Themis Sapsis (MIT)
10:10	(YIP) NOMAD: Nonlinear Manifold Decoders for Operator Learning	Paris Perdikaris (University of Pennsylvania)
10:35	BREAK	
10:45	(YIP) Adaptive, Data-Driven Model Reduction for Shock-Dominated Flows to Enable Many-Query Computational Physics	Matt Zahr (University of Notre Dame)
11:10	(YIP) Context-Aware Controller Inference for Stabilizing Dynamical Systems From Scarce Data	Benjamin Peherstorfer (Courant Institute, NYU)
11:35	(YIP) Learning Deep Nonlocal Operators for Heterogeneous Material Modeling	Yue Yu (Lehigh University)
12:00	LUNCH	
13:00	Positivity/Bound/Length Preserving Schemes for Complex Nonlinear Systems with a new Lagrange Multiplier Approach	Jie Shen (Purdue University)
13:25	Mesh Generation and AI-enhanced Algorithms for Modeling Complex Materials Systems	Soheil Soghrati (Ohio State University)
13:50	Roles of Information Criteria for Model Calibration, Validation, Updating, and Surrogate Construction	Ralph Smith (NCSU)
14:15	Low-Rank Multi-Fidelity Algorithms, Model Selection, and Budget Allocation	Akil Narayan (University of Utah) Alireza Doostan (UC Boulder)
14:55	BREAK	
15:15	Performance of Mixed Precision Additive Runge–Kutta Methods	Sigal Gottlieb (U Mass, Dartmouth)
15:40	Machine Learned Adaptive Modeling for Optimization of Complex Systems	Ed Forster, Phil Beran, Chris Schrock (AFRL/RQVC)
16:05	MURI: Machine Learning for Physics-based Systems: Optimal Approximations, Architectures, and Training	Karen Willcox, Omar Ghattas (UT Austin)
17:00	MEETING ADJOURN FOR THE DAY	

Agenda Day 2 | Tuesday- August 16, 2022
All times are EDT

Time	Topic	Speaker
8:30-9:00	Zoom Login	
9:00	SIAC MAGIC Toolbox: A Filtering Framework and Julia Software Package	Jennifer Ryan (Colorado School of Mines)
9:25	A Bayesian Machine-Learning Perspective on the Quantum Many-Body Problem	George Booth (King's College)
9:50	Information Metrics and Stochastic Optimization Methods for Robust and Trustworthy Statistical Learning	Markos Katsoulakis, Luc Rey-Bellet (U Mass- Amherst), Paul Dupuis (Brown University)
10:30	Collocation Methods for PDEs with Integral Fractional Laplacian	Zhongqiang Zhang (WPI)
10:55	Dimension Reduction and Interpolation in Parameter Space	Daniel Tartakovsky (Stanford University)
11:20	Damage Detection with Spectral Representations	Amanda Criner (AFRL/RXCA)
11:45	LUNCH	
12:45	Program Status Update	Dr. Fariba Fahroo (AFOSR)
13:00	Optimal Mass Transport in Engineering, Medicine, Physics: Dissipation & Power in Thermodynamic and Biological Processes	A. Tannenbaum (Stony Brook University), Tryphon Georgiou (UC Irvine)
13:30	Multi-Scale Approaches for Physics Understanding and Model Development of Turbulent Combustion	Ramakanth Munipalli (AFRL/RQRC)
13:55	Invariant-Domain Preserving High-Order Implicit Explicit Time Stepping for Nonlinear Conservation Equations	Jean-Luc Guermond, Bojan Popov (TAMU)
14:20	Explicit-Implicit-Null (EIN) Time-Marching for High Order PDEs	Chi-Wang Shu (Brown University)
14:45	BREAK	
15:00	High-Order Large Eddy Simulation at the Extreme Scales	ZJ Wang (University of Kansas)
15:25	Towards Large-Scale Quantum Accuracy Materials Simulations	Vikram Gavini (U. Michigan)
15:50	MURI: Revolutionary Advances in Correlated Electron Materials: From Strongly Correlated Electrons to Large Scale DFT and Quantum Embedding	Carlos Garcia-Cervera (UCSB)
16:50	Discussions	
17:00	MEETING ADJOURN FOR THE DAY	

Agenda Day 3 Wednesday - August 17, 2022 All times are EDT		
Time	Topic	Speaker
8:30-9:00	Zoom Login	
9:00	Implicit Multi-Scale Plasma Simulations Using Low Cost Matrix-Free Methods for Partial Differential Equations	Andrew Christlieb (Michigan State University)
9:25	A Conservative Adaptive Low Rank High Order Tensor Approach for Nonlinear Vlasov Equations	Jingmei Qiu (U. Delaware)
9:50	Simulation of High Power Optical Fiber Amplifiers	Leszek Demkowicz (UT Austin) Jay Gopalakrishnan (Portland State University)
10:30	Structure Preserving Particle Method for Vlasov-Landau Equation	Jingwei Hu (University of Washington)
10:55	BREAK	
11:05	Multiscale Stochastic Modeling, Conditioning, and Simulation of Rare Events	Roger Ghanem (USC)
11:45	Koopman Mode Analysis of Spatially Extended Dynamical Systems with Applications to Agent-Based Models	Maria Fonoberova (AIMDyn Inc.)
12:10	LUNCH	
13:10	The Science of Learning from Observations: Leveraging Scientific Computation with Intrinsic Machine Learning Models and Lifelong Learning	Mauro Maggioni (Johns Hopkins University)
13:50	Rare Events: Analysis, Computation, and Robustness	Jose Blanchet (Stanford University), Youssef Marzouk (MIT)
14:45	BREAK	
15:00	Recent Developments on Numerical Tensor Methods for High-Dimensional PDEs	Daniele Venturi (UC Santa Cruz)
15:25	Reduced-Order Modeling using Time-Dependent Bases with Applications in Turbulent Combustion and Uncertainty Quantification	Hessam Babaee (U. Pittsburgh)
15:50	Data Driven Predictive Modeling of Complex Dynamical Systems	Dongbin Xiu (Ohio State University)
16:15	In-Situ, Conservative Particle Merging with Octree Sorting	William Taitano (AFRL, Edwards AFB)
16:45	Comments/Discussions	

Agenda Day 4 August 18, 2022 All times are EDT		
Time	Topic	Speaker
8:30-9:00	Zoom Login	
9:00	Machine Learning to Improve Turbulence Modeling	Chris Schrock (AFRL/RQ)
9:25	Optimization Under Uncertainty - A Generalized Koopman Expectation Framework	Adam Gerlach (AFRL/RQQA)
9:50	Unified Mathematical Theory of Online Threats Across Scales: A New Frontier for Burgers Equations, Shocks, Turbulence and PINNs	Neil Johnson (GWU)
10:15	Embedded Boundary Methods with Stability, Accuracy, and Smoothness Guarantees for Multidisciplinary Design, Analysis and Optimization	Charbel Farhat (Stanford University)
10:40	Learning in Multi-Scale Models with Stochastic Source Coupling	Guus Jacobs (SD State University)
11:05	An Arbitrarily High-Order Spectral Difference Method with Divergence Cleaning (SDDC) for Compressible Magnetohydrodynamic Simulations on Unstructured Grids	Chunlei Liang (Clarkson University)
11:30	LUNCH	
12:40	A Machine Learning Framework for High-Dimensional Mean Field Games and Optimal Control	Lars Ruthotto (Emory)
13:05	Solving Inverse Problems in Hypersonic Boundary Layers Using Operator Networks	Tamer Zaki (JHU)
13:30	MURI: Learning and Meta-Learning of Partial Differential Equations via Physics-Informed Neural Networks: Theory, Algorithms, and Applications	George Karniadakis (Brown University)
14:30	MURI: Innovations in Mean-Field Game Theory for Scalable Computation and Diverse Applications	Stan Osher (UCLA)
15:30	BREAK	
15:40	Dissipative Potentials for Anisotropic Heterogeneous Media	Oana Cazacu (UFL- REEF)
16:05	Scale-Bridging Generalized Finite Element Methods for Structural Dynamics and Wave Propagation	C. Armando Duarte (University of Illinois at Urbana-Champaign)
16:30	Mesh Based Neural Networks for Estimating High Fidelity CFD from Low Fidelity Input	Daniel Reasor (AFRL/RWWN)
17: 00	MEETING ADJOURN FOR THE DAY	

Agenda Day 5 August 19, 2022 All times are EDT		
Time	Topic	Speaker
8:30-9:00	Zoom Login	
9:00-10:00	Discussion Session on Future Directions	
10:00-12:00	Information Break-out Sessions	
12:00	MEETING ADJOURN	

**PROPULSION and POWER LIQUID ROCKET ENGINE RESEARCH PROGRAM
19 AUGUST 2022-Friday-starting at 13:00 EST**

- 1) 13:00-13:10 INTRODUCTION, Ramakanth Munipalli and Mitat Birkan (10 minutes)
- 2) 13:10-13:30 Dynamics of High Pressure Reacting Shear Flows
RAMAKANTH MUNIPALLI, Aerospace Systems Directorate (AFRL/RQR)
EDWARDS AFB CA (20 min)
- 3) 13:30-15:00 COE: Multi-Fidelity Modeling of Rocket Combustor Dynamics
DURASAMY, KARTHIK, THE UNIVERSITY OF MICHIGAN, (1 1/2 hours)
- 4) 15:00-15:40 BREAK
- 5) 15:40-16:00 A new paradigm for transcritical injection simulations and understanding
BANUTI, DANIEL, THE UNIVERSITY OF NEW MEXICO (DEPSCOR) (20 min)
- 6) 16:00-16:20 Detailed Simulation and Modeling of Turbulent Multiscalar Mixing and
Combustion Processes at Supercritical Conditions
YANG, VIGOR, GEORGIA TECH RESEARCH CORPORATION (20 min)
- 7) 16:20-16:40 Studies of Finite-Rate Effects Relevant to Modeling of Liquid-Propellant
Rocket Combustion Instabilities
SANCHEZ, ANTONIO, UNIVERSITY OF CALIFORNIA, SAN DIEGO (20 min)
- 8) 16:40-17:20 BREAK
- 9) 17:20-17:40 Exploration of Acoustically Coupled Combustion Instabilities Relevant to
Rocket Propulsion Systems
KARAGOZIAN, ANN, UNIVERSITY OF CALIFORNIA LOS ANGELES (20 min)
- 10) 17:40-18:00 High-Pressure LPRE Combustion Dynamics: Low-Cost Computation and
Stochastic Analysis
SIRIGNANO, WILLIAM, UNIVERSITY OF CALIFORNIA IRVINE (20 min)