Meshfree and Particle Methods: Applications and Theory

A USACM Thematic Conference of the Technical Thrust Area on Novel Methods in Computational Engineering and Sciences

September 10-12, 2018
Santa Fe, New Mexico

Organizing Committee:

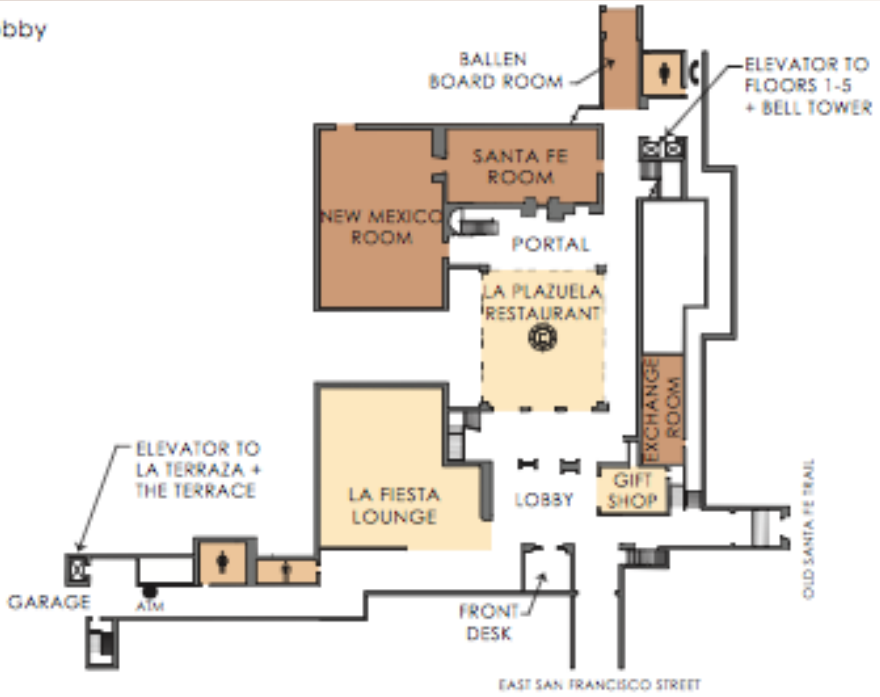
Joe Bishop, ***Sandia National Laboratories***
Jacob Koester, ***Sandia National Laboratories***
Bo Li, ***Case Western Reserve University***
Deborah Sulsky, ***University of New Mexico***
Duan Zhang, ***Los Alamos National Laboratory***

Partial support by Sandia National Laboratories and Los Alamos National Laboratory is gratefully acknowledged.

USACM

First Floor

Lobby



La Fonda On the Plaza™

100 E. San Francisco Street
Santa Fe, New Mexico 87501

Second Floor

Mezzanine & Ballroom

Third Floor

La Terraza

Elevator | Stairs | Lift | Restrooms | House Phone

Meshfree and Particle Methods: Application and Theory

September 10-12, 2018
La Fonda on the Plaza, Santa Fe, New Mexico

Sunday, September 9

4:00 – 6:00 pm	Registration, La Terraza Foyer (3rd floor)
6:00 – 7:00 pm	Opening Reception, La Terraza (3rd floor)

Monday, September 10

7:30	Registration, Lumpkins Ballroom Foyer
7:30 – 8:30	Continental Breakfast, Lumpkins Ballroom North (2nd Floor)

Room: Lumpkins Ballroom South (2nd floor)

8:00 – 8:10	Opening Remarks
8:10 – 8:50	***Plenary Talk***: **Steve Attaway** *The Future for Modeling Extreme Events: Exemplar Problems for Meshless Methods*

Room: New Mexico (1st floor)
Session 1-1: Mathematical Theory and Method Development 1
Chair: Pavel Bochev

9:00 – 9:25	Siddhant Kumar*, Dennis Kochmann, Kostas Danas *Enhanced Local Maximum-entropy Approximation for Stable Meshfree Simulations*
9:25 – 9:50	Qizhi He*, J.S. Chen *A Machine Learning Enhanced Data-driven Simulation of Solids and Structures with Noisy Database*
9:50 – 10:15	Alexander Lukyanov*, Kees Vuik *A Stable SPH Discretization of the Elliptic Operator with Heterogeneous Coefficients*

Room: Santa Fe (1st floor)
Session 1-2: Multi-Scale 1
Chair: Pablo Seleson

9:00 – 9:25	C. Armando Duarte*, Haoyang Li *A Scale-Bridging Generalized Finite Element Method for Parallel Simulations of Spot Welds in Large Structures*
9:25 – 9:50	Frank Beckwith*, J.S. Chen *An Immersed Reproducing Kernel Particle Method for Modeling Inhomogeneous Media*
9:50 – 10:15	Chuanqi Liu* *Multi-scale Modelling of Granular Pile Collapse by Using Material Point Method and Discrete Element Method*

10:15 – 10:30	Break, Lumpkins Ballroom North (2nd Floor)

Room: New Mexico (1st floor)
Session 2-1: Comparison of Related Methods 1
Chair: C.T. Wu

10:30 – 10:55	Michael Tupek*, David Littlewood, Jacob Koester *Meshfree Cohesive Phase-Field Peridynamics*
10:55 – 11:20	Marco Pasetto*, Yu Leng, J.S. Chen, John T. Foster, Pablo Seleson *A Reproducing Kernel Enhanced Approach for Peridynamic Solutions*
11:20 – 11:45	Dandan Lyu*, Shaofan Li, Bo Ren, C.T. Wu *Comparison of Molecular Dynamics (MD) with Multiscale Crystal Defect Dynamics (MCDD)*

Room: Santa Fe (1st floor)
Session 2-2: Multi-Scale 2
Chair: Julia Plews

10:30 – 10:55	Nikolai D. Petsev*, L. Gary Leal, M. Scott Shell *Multicomponent Molecular-Continuum Simulations Using Smoothed Dissipative Particle Dynamics*
10:55 – 11:20	Nikos Gastonis*, Jun Yang *Non-Isothermal Smoothed Dissipative Particle Dynamics*
11:20 – 11:45	Alexandre Tartakovsky* *SPH Model for Nanoscale Multiphase Flows*

11:45 – 1:00 Lunch, Lumpkins Ballroom North (2nd Floor)

Room: Lumpkins Ballroom South (2nd floor)

1:00 – 1:40	***Plenary Talk**:* **N. Sukumar** *Maximum-Entropy Meshfree Approximation Scheme in Computational Mechanics*

Room: New Mexico (1st floor)
Session 3-1: Comparison of Related Methods 2
Chair: Michael Tupek

1:50 – 2:15	Joseph Bishop* *A Comparison of Mesh-free and Mesh-based Lagrangian Approximations of a Manufactured Shear-dominated Deformation Field*
2:15 – 2:40	C.T. Wu*, Wei Hu, Youcai Wu, Huang Li *Computational Modeling of Joint Failure Using Finite Element and Meshfree Methods*
2:40 – 3:05	Hailong Chen* *A Comparison Study on Peridynamic Models Using Irregular Non-Uniform Spatial Discretizations*
3:05 – 3:30	Austin Isner*, Duan Zhang *Improving the Integration Accuracy of the Material Point Method*

Room: Santa Fe (1st floor)
Session 3-2: Mathematical Theory and Method Development 2
Chair: Nathaniel Trask

1:50 – 2:15	Michael Hillman*, Guohua Zhou *Generalized Reproducing Kernel Peridynamics*
2:15 – 2:40	Joe Ward*, Francis Narcowich *Local Lagrange Functions and the BBO Paradigm*
2:40 – 3:05	Francis Narcowich*, Anat Amir, Joseph Ward *Meshfree Extrapolation with Application to BBO (t,k) Systems and Non-local Diffusion*
3:05 – 3:30	Alfredo Sanchez-Rivadeneira*, C. Armando Duarte *A Stable Generalized/eXtended FEM with Discontinuous Interpolant for Fracture Mechanics*

3:30 – 3:45 Break, Lumpkins Ballroom North (2nd floor)

Room: New Mexico (1st floor)
Session 4-1: Damage and Fracture
Chair: David Littlewood

3:45 – 4:10	Albert Ziegenhagel*, Alexander Lukyanov, Marc Alexander Schweitzer *A Partition of Unity Method for Thermal Hydraulic Fracturing*
4:10 – 4:35	Masoud Behzadinasab*, John Foster *Peridynamic Modeling of Dynamic Fracture in Metallic Materials*
4:35 – 5:00	Bo Li*, Hao Jiang *Micromechanical Studies of Compressive Strength in Brittle Polycrystalline Materials at High Strain Rates*

Room: Santa Fe (1st floor)
Session 4-2: Mathematical Theory and Method Development 3
Chair: Mauro Perego

3:45 – 4:10	Grady Wright* *Localized High-order Meshfree Methods for Semi-Lagrangian Advection on Surfaces*
4:10 – 4:35	Nathaniel Trask*, Pavel Bochev, Mauro Perego *Conservative Meshfree Discretization*
4:35 – 5:00	Christian Rieger* *Kernel-based Reconstruction Methods for Uncertainty Quantification*

5:15 – 6:45 Poster Session, Mezzanine (List of poster presentations on last page)

Tuesday, September 11

7:30	Registration, Lumpkins Ballroom Foyer
7:30 – 8:30	Continental Breakfast, Lumpkins Ballroom North (2nd Floor)

Lumpkins Ballroom South (2nd floor)

8:30 – 9:10	**Plenary Talk: Jerry Brackbill** *Particle Methods: A Long View*

9:10- 9:25 Break, Lumpkins Ballroom North (2nd Floor)

Room: New Mexico (1st floor)
Session 5-1: Shock and Hydrodynamics
Chair: J.S. Chen

9:25 – 9:50	Zirui Mao*, G.R. Liu, Tao Lin, Xiangwei Dong *A Lagrangian Gradient Smoothing Method (L-GSM) Model for Free Surface Flows*
9:50 – 10:15	Tsung-Hui Huang*, J.S. Chen *Eulerian Reproducing Kernel Particle Method for Shock Modeling*
10:15 – 10:40	Alexander Lukyanov*, Steven B. Segletes, Vladimir M. Sadovskii *Generalized Anisotropic Gruneisen Parameter: A Vector Equation of State for Anisotropic Materials*
10:40 – 11:05	Mikhail Shashkov*, Wurigen Bo *Arbitrary Reconnection-based Arbitrary Lagrangian Eulerian Method – A-ReALE*
11:05 – 11:30	Jonghyuk Baek*, Guohua Zhou, J.S. Chen, Michael Hillman *Coupled Shock-Plasticity-Damage Modeling of Explosive Welding by RKPM*

Room: Santa Fe (1st floor)
Session 5-2: Multi-Scale 3
Chair: C. Armando Duarte

9:25 – 9:50	Mei Chandler*, Ruth Cheng *Applications of Discrete Element Method (DEM) in Micromechanical Modeling of Materials*
9:50 – 10:15	Dennis Dusseldorf*, Marc Alexander Schweitzer *A Partition of Unity Method using Fine-Scale Enrichments*
10:15 – 10:40	WaiChing Sun*, Kun Wang *Deep-reinforcement-learning-enhanced Computational Failure Mechanics Across Multiple Scales*
10:40 – 11:05	Pablo Seleson* *Coupling Methods in Peridynamics for Effective Failure and Damage Simulation*
11:05 – 11:30	Dong Qian*, Rui Zhang, Clint Nicely *A Concurrent Multiscale Approach to Coupled Peridynamic/FEM Simulation*

11:30 – 12:45 Lunch, Lumpkins Ballroom North (2nd floor)

Lumpkins Ballroom South (2nd Floor)

12:45 – 1:25 **Plenary Talk: Dongdong Wang**
Meshfree Methods and Isogeometric Analysis: Consistency Conditions, Reproducing Kernel Linkage and Local Refinements

Room: New Mexico (1st Floor)
Session 6-1: Rapid Design-to-Analysis
Chair: Joseph Bishop

1:35 – 2:00 Scott Roberts*, Dan Bolintineanu, Mark Ferraro, Jeremy Lechman, David Noble, Ishan Srivastava, Bradley Trembacki
Application of the Conformal Decomposition Finite Element Method for Rapid Turnaround Analysis of Tomographic Imaging and Particle Simulation Based Mesostructures

2:00 – 2:25 Mark Rashid*, Andrew Baldwin, Alipasha Sadri
Reimagining the CAE Workflow Via Polyhedral Finite Elements

2:25 – 2:50 Jacob Koester*, J.S. Chen, Michael Tupek, Scott Mitchell, Joseph Bishop
The Conforming Reproducing Kernel Method for an Agile Design-to-Simulation Workflow

2:50 – 3:15 Mohamed Ebeida*
VoroCrust: Conforming Voronoi Meshing of Non-convex Domains with Sharp Features and Narrow Regions

3:15 – 3:40 Julia Plews*, Matthew Mosby, *Advances in a Multiscale Generalized FEM for Large-scale Simulations*

Room: Santa Fe (1st Floor)
Session 6-2: Implementation and HPC
Chair: Frank Beckwith

1:35 – 2:00 Paul Kuberry*, Peter Bosler
Meshless Transfer for Earth System Models via the Compadre Toolkit

2:00 – 2:25 David Littlewood*, Bart van Bloemen Waanders, Arun Hegde, Adam Cook
Computational Peridynamics with Application to Additively Manufactured Ceramics

2:25 – 2:50 Swarnava Ghosh*
A Novel Real-space Formulation of Density Functional Theory: Designing Next Generation Magnesium Alloys

2:50 – 3:15 Nathaniel Morgan*, Evan Lieberman, Konstantin Lipnikov
A High-order Lagrangian Method Based on Material Points and Piecewise Polynomial Maps

3:15 – 3:40 Stuart Slattery*, Bob Bird, Guangye Chen, Time Germann
A Co-designed Library for Exascale Particle Simulations

3:40 – 3:55 Break, Lumpkins Ballroom North (2nd Floor)

Room: New Mexico (1st Floor)
Session 7-1: Penetration and Perforation
Chair: Michael Hillman

3:55 – 4:20	Bo Li*, Jiang Fan, Qinghao Yuan, Qingxuan Wei, Guangchen Bai *Optimal Transportation Meshfree Simulation of Whipple Shield under Hypervelocity Impact*
4:20 – 4:45	David Littlefield*, Gerald Pekmezi *A Multiscale Model for Sand*
4:45 – 5:10	Stewart Silling* *Modeling Penetration and Perforation with Peridynamics*
5:10 – 5:35	Jesse Sherburn*, William Heard *Reproducing Kernel Particle Method Modeling of Ultra-High Performance Concrete Flyer Plate Experiments*
5:35 – 6:00	James D. Walker*, Sidney Chocron, Stephen R. Beissel, Donald J. Grosch, Daniel D. Durda *Particle Conversion Methods for Computing Momentum Enhancement due to Hyper-velocity Impact*

Room: Santa Fe (1st Floor)
Session 7-2: Advanced Manufacturing
Chair: Scott Roberts

3:55 – 4:20	Hao Wang*, Bo Li *Numerical Modeling of the Hot Forming Process of Composite Materials*
4:20 – 4:45	Zongyue Fan*, Bo Li, Hao Wang *Direct Numerical Simulation of Powder Bed Fusion Based Additive Manufacturing of Metals*
4:45 – 5:10	Pan Xiaofei*, C. T. Wu, W. Hu, Y.C. Wu *Smoothed Particle Galerkin Method with a Momentum-Consistent Smoothing Algorithm for Explicit Coupled Thermal-Structural Analysis*
5:10 – 5:35	Dan S. Bolintineanu*, Daniel R. Moser, Jeremy B. Lechman *Discrete Element Modeling of Powder Spreading for Metal Additive Manufacturing*
5:35 – 6:00	Zhen Chen* *Integrating Nonlocal Constitutive Modeling with Nonlocal MPM for Better Evaluating Multi-Physical Responses*

6:30 – 7:00	Reception, La Terraza (3rd Floor)
7:00 – 9:30	Dinner, La Terraza (3rd Floor) **Speaker: Joseph Teran,** *Snow Business: Elastoplasticity Simulation with the Material Point Method*

Wednesday, September 12

7:30	Registration, Lumpkins Ballroom North (2nd Floor)
7:30 – 8:30	Continental Breakfast, Lumpkins Ballroom North (2nd Floor)

Lumpkins Ballroom South (2nd Floor)

8:10 – 8:50	**Plenary Talk: Sergio Idelsohn** *Particle Methods and Turbulent Flows*
8:50 – 9:00	Break, Lumpkins Ballroom North (2nd Floor)

Room: New Mexico (1st Floor)
Session 8-1: Fluid-Structure Interaction and Other Coupled Problems
Chair: Duan Zhang

9:00 – 9:25	Renjie Ke*, Bo Li *A Monolithic Lagrangian Meshfree Method for Fluid-Structure Interaction Problems within the OTM Framework*
9:25 – 9:50	David Kamensky*, Yuri Bazilevs *Peridynamic Contact Modeling in I(mmer)sogeometric Analysis*
9:50 – 10:15	Yuri Bazilevs* *Recent Advances in IGA-Meshfree Coupling for Air-Blast FSI*

Room: Santa Fe (1st Floor)
Session 8-2: Mathematical Theory and Method Development 4
Chair: Paul Kuberry

9:00 – 9:25	J.S. Chen*, Sheng-Wei Chi, Mike Hillman, Hsin-Yun Hu *Implicit Gradient for Numerical Solution of PDEs*
9:25 – 9:50	Mauro Perego*, Pavel Bochev, Nathaniel Trask, Peter Bosler, Paul Kuberry, Kara Peterson *Generalized Moving Least Squares: Approximation Theory and Applications*
9:50 – 10:15	Chad Hammerquist*, Yamina Aimene *Particle-based Inelasticity vs Grid-based Updates in MPM*
10:15 – 10:30	Break, Lumpkins Ballroom North (2nd Floor)

Room: New Mexico (1st Floor)
Session 9-1: Mathematical Theory and Method Development 5
Chair: Nathaniel Trask

10:30 – 10:55	Kuan-Chung Lin*, Michael Hillman *Consistent Strong Enforcement of Essential Boundary Conditions in Meshfree Methods*
10:55 – 11:20	Huaiqian You*, Nathaniel Trask, Yue Yu, Michael Parks *An Asymptotically Compatible Meshfree Quadrature Rule for Nonlocal Problems with Applications to Peridynamics*
11:20 – 11:45	Duan Zhang* *Consistency Considerations for Thermodynamically Nonequilibrium Problems Simulated Using Heterogeneous Multiscale Methods*
11:45 – 12:10	Saili Yang*, Michael Hillman *A Finite Volume Reproducing Kernel Particle Method*

Room: Santa Fe (1st Floor)
Session 9-2: Geoscience and Natural Disasters
Chair: Deborah Sulsky

10:30 – 10:55	Elizaveta Wobbes*, Matthias Moller, Cornelis Vuik, Pascal De Koster, Vahid Galavi *Reduction of Numerical Errors in the Material Point Method*
10:55 – 11:20	Haoyan Wei*, J.S. Chen *A Meshfree Computational Framework for Modeling Hydro-Mechanical Damage Processes in Porous Geomaterials*
11:20 – 11:45	Erik Jensen*, Richard Regueiro, Boning Zhang *1D MPM-DEM Hierarchical Multiscale Modeling of a Split Hopkinson Pressure Bar Experiment on Dry Colorado Mason Sand*
11:45 – 12:10	Kara Peterson*, Adrian Turner, Andrew Roberts, Dan Bolintineanu, Dan Ibanez, Travis Davis *A Discrete Element Model for Sea Ice*

List of poster presentations follows on the next page.

Poster Presentations

Jonghyuk Baek	*Coupled Shock-Plasticity-Damage Modeling of Explosive Welding by RKPM*
Masoud Behzadinasab	*Sandia Fracture Challenge 2017: Peridynamics Blind Prediction of Dynamic Crack Growth in Ductile Materials*
Frank Beckwith	*An Immersed Reproducing Kernel Particle Method for Modeling Inhomogeneous Media*
Christian Bueno	*Meshfree Manifold Learning Methods for Dimension Reduction of Stochastic Dynamical Systems*
Zongyue Fan	*Direct Numerical Simulation of Powder Bed Fusion Based Additive Manufacturing of Metals*
Swarnava Ghosh	*A Novel Coarse Grained Formulation of Density Functional Theory: Designing Next Generation Magnesium Alloys*
Qizhi He	*A Machine Learning Enhanced Data-driven Simulation of Solids and Structures with Noisy Database*
Tsung-Hui Huang	*Eulerian Reproducing Particle Method for Shock Modeling*
Hao Jiang	*Micromechanical Studies of Compressive Strength in Brittle Polycrystalline Materials at High Strain Rates*
Renjie Ke	*A Monolithic Lagrangian Meshfree Method for Fluid-Structure Interaction Problems within the OTM Framework*
Siddhant Kumar	*Enhanced Local Maximum-entropy Approximation for Stable Meshfree Simulations*
Chuanqi Liu	*Multi-scale Modelling of Granular Materials using MPM and DEM*
Kuan-Chung Lin	*Consistent Strong Enforcement of Essential Boundary Conditions in Meshfree Methods*
Marco Pasetto	*A Reproducing Kernel Enhanced Approach for Peridynamic Solutions*
Alfredo Sanchez-Rivadeneira	*A Stable Generalized/eXtended FEM with Discontinuous Interpolant for Fracture Mechanics*
Jeremy Trageser	*Modeling Anisotropy in Two-dimensional Peridynamic Models*
Haoyan Wei	*A Meshfree Computational Framework for Modeling Hydro-Mechanical Damage Processes in Porous Geomaterials*
Hao Wang	*Numerical Modeling of the Hot Forming Process of Composite Materials*
Kun Wang	*Mastering a Game that Generates Theoretical-consistent, Micro-structured-based Traction-Separation Laws without Human Intervention*
Elizaveta Wobbes	*Conservative Taylor Least Squares Function Reconstruction for Material Point Method*
Saili Yang	*A Finite Volume Reproducing Kernel Particle Method*
Huaiqian You	*An Asymptotically Compatible Meshfree Quadrature Rule for Nonlocal Problems with Applications to Peridynamics*