

Mustafa A Mohamad

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Citizenship: USA and Canada

Education

- 9/13 – 9/17 **Massachusetts Institute of Technology (MIT)**
PhD, Mechanical Engineering and Computation
Major in *Stochastic and Computational Engineering* and Minor in Fluids and Dynamics
Thesis Direct and adaptive schemes for extreme event statistics in complex dynamical systems
Committee: T. P. Sapsis, A. T. Patera, Y. M. Marzouk
Coursework (select): Machine Learning, Optimization Methods, Parallel Computing, Numerical Methods for PDEs, Fast Numerical Methods for PDEs, Nonlinear Dynamics and Waves, Numerical Methods for Stochastic Modeling and Inference, Advanced Fluid Mechanics
- 9/13 – 9/15 **Massachusetts Institute of Technology (MIT)**
SM, Mechanical Engineering, GPA 5/5
Thesis Probabilistic quantification of intermittently unstable dynamical systems
Advisor: T. P. Sapsis
- 9/09 – 12/12 **University of Illinois at Urbana-Champaign (UIUC)**
BS, Engineering Mechanics, Minor in Mathematics, GPA 4/4
Bronze Tablet scholar (highest honors for top 3% of graduating class)
Advisor: S. Hilgenfeldt

Appointments

- 9/17 – now **Postdoctoral Associate, Courant Institute of Mathematical Sciences, NYU, New York, NY**
Research in data assimilation and stochastic systems.
Mentor: A. J. Majda.
- 9/13 – 9/17 **Graduate Research Assistant, Department of Mechanical Engineering, MIT, Cambridge, MA**
Research in uncertainty quantification of extreme events.
Advisor: T. P. Sapsis.
- 1/13 – 3/13 **Jr. Mechanical Specialist, Grantech International, Calgary, AB, Canada**
Engineering design and equipment specification for an offshore natural gas project.
- 9/11 – 5/12 **Undergraduate Research Assistant, University of Illinois at Urbana-Champaign, Urbana, IL**
Experiments on permeability and strain of porous media to assess cardiac cycles on brain tissue.
Advisor: S. Hilgenfeldt.

Journal Publications

1. M. A. Mohamad, A. J. Majda, Eulerian energy spectra estimation from Lagrangian drifters through joint data assimilation and MCMC parameter estimation, (in preparation).
2. M. A. Mohamad, A. J. Majda, Recovering the Eulerian energy spectrum from noisy Lagrangian tracers, *Physica D*, 403, 132374, Feb 2020.
3. M. A. Mohamad, A. J. Majda, Eulerian and Lagrangian statistics in an exactly solvable turbulent shear model with a random background mean, *Physics of Fluids*, 31, 105115, Oct 2019.
4. M. A. Mohamad, T. P. Sapsis, A sequential sampling strategy for extreme event statistics in nonlinear dynamical systems, *Proceedings of the National Academy of Sciences*, 115, p. 11138-11143, Oct 2018.
5. H. K. Joo, M. A. Mohamad, T. P. Sapsis, Heavy-tailed response of structural systems subjected to extreme forcing events, *ASME Journal of Computational and Nonlinear Dynamics*, Volume 13 (9), 090914, Jul 2018
6. H. K. Joo, M. A. Mohamad, T. P. Sapsis, Extreme events and their optimal mitigation in nonlinear structural systems excited by stochastic loads: Application to ocean engineering systems, *Ocean Engineering*, Volume 142, pp. 145-160, Sept 2017.
7. M. A. Mohamad, W. Cousins, T. P. Sapsis, A probabilistic decomposition-synthesis method for the quantification of rare events due to internal instabilities, *Journal of Computational Physics*, Volume 322, pp. 288-308, Oct 2016.

8. M. A. Mohamad, T. P. Sapsis, Probabilistic response and rare events in Mathieu's equation under correlated parametric excitation, *Journal of Ocean Engineering*, Volume 120, pp. 289-297, Jul 2016.
9. M. A. Mohamad, T. P. Sapsis, Probabilistic description of extreme events in intermittently unstable systems excited by correlated stochastic processes, *SIAM/ASA Journal on Uncertainty Quantification* Volume 3 (1), pp. 709-736, Aug 2015.

Conference Publications & Proceedings

1. M. A. Mohamad, T. P. Sapsis, Efficient sampling for extreme event statistics of the wave loads on an offshore platform, The 30th American Towing Tank Conference, West Bethesda, Maryland, Oct 2017.
2. T. P. Sapsis, M. A. Mohamad, Probabilistic quantification of extreme events in complex systems, 9th European Nonlinear Dynamics Conference, Budapest, Hungary, Jun 2017.
3. T. P. Sapsis, M. A. Mohamad, H. K. Joo, Extreme response mitigation of stochastically forced nonlinear structures, 9th European Nonlinear Dynamics Conference, Budapest, Hungary, Jun 2017.
4. M. A. Mohamad, T. P. Sapsis, Probabilistic response of Mathieu equation excited by correlated parametric excitation, Proceedings of STAB 2015, Glasgow, UK, Jun 2015.
5. M. A. Mohamad, T. P. Sapsis, Analytical approximation of the heavy-tail structure for intermittently unstable complex modes, Proceedings of the Dynamic Data Driven Environmental Systems Science Conference, Cambridge, Massachusetts, Nov 2014.

Software

- See GitHub profile: <https://github.com/musm>
- **Julia Language:** top 40 contributor to the core Julia language repository.
- **SLEEF.jl** (<https://github.com/musm/SLEEF.jl>)
Original author: A pure Julia port of the high-performance C language vectorized elementary math function library.
- **MATLAB.jl** (<https://github.com/JuliaInterop/MATLAB.jl>)
Julia Package: Major contributor to the package designed to interface MATLAB from Julia.
- **HDF5.jl** (<https://github.com/JuliaIO/HDF5.jl>). Maintainer and contributor.

Media

- Technique quickly identifies extreme event statistics: Machine-learning model provides risk assessment for complex nonlinear systems, including boats and offshore platforms, *MIT News*, Oct 2018.
- Predicting fluids flows from Lagrangian drifter observations, *CAOS News*, NYU, Oct 2019.

Teaching

- Fall 2019: Uncertainty Quantification in Turbulent Dynamical Systems (co-instructor)

Organization

- Mini-Symposium: State estimation, prediction, and uncertainty quantification in geophysics, Part 1 & 2, 9th International Congress on Industrial and Applied Mathematics, Valencia, Spain, (July 18, 2019).

Awards & Fellowships

2017	SNAME Travel Award
2015	Abkowitz Travel Award
9/14 - 5/15	ABS Fellowship
9/13 - 1/14	Pappalardo Fellowship
2013	Bronze Tablet Award (highest honors at UIUC for top 3% of college's graduating class)
2009 - 2019	James Scholar (engineering honors program)
2012 - 2013	Fred B. Seely Scholarship
5/12 - 8/12	NSERC Undergraduate Student Research Award
4/2012	Fred B. Seeley Award (outstanding senior in Engineering Mechanics)
2011 - 2012	ISUR Scholarship
2011 - 2012	George M. and Ruth N. Sinclair Scholarship

2010 – 2011 Morris Stern Scholarship

2009 Alexander Rutherford Scholarship

Invited Talks & Presentations

- Predicting the Eulerian energy spectrum from Lagrangian drifters, Scientific Grand Challenges and New Perspectives in Applied Mathematics, Pacific Institute for the Mathematical Sciences, University of Victoria, Victoria, Canada (July 24, 2019).
- Predicting the Eulerian energy spectrum from noisy Lagrangian tracers, 9th International Congress on Industrial and Applied Mathematics, Valencia, Spain, (July 18, 2019).
- A Gaussian process regression method for sampling tail events in dynamical systems, SIAM Conference on Dynamical Systems, Snowbird, UT, (May 20, 2019).
- Strategies for extreme event quantification in intermittent dynamical systems, Applied and Computational Mathematics Seminar, University of Wisconsin-Madison, Host: Prof. Nan Chen, (Apr 19, 2019).
- Sampling full extreme event statistics for nonlinear dynamical systems through sequential surrogate models, 13th World Congress in Computational Mechanics, New York, NY, (Jul 24, 2018).
- Strategies for extreme event quantification in intermittent dynamical systems, XI International Conference on Computational Heat, Mass and Momentum Transfer, Krakow, Poland, **Keynote**, (May 21, 2018).
- Sequential sampling for extreme event statistics in nonlinear dynamical systems, SIAM Conference on Uncertainty Quantification, Garden Grove, California, (Apr 16, 2018).
- Efficient sampling for extreme event statistics of the wave loads on an offshore platform, 30th American Towing Tank Conference, West Bethesda, Maryland, (Oct 4, 2017).
- A sequential optimization sampling method for the estimation extreme of event statistics for dynamical Systems, 1st International Conference on InfoSymbiotics/DDDAS, Cambridge, MA, (Aug 7, 2017).
- Optimal experimental design for extreme event statistics in nonlinear dynamical systems, SIAM Conference on Dynamical Systems, Snowbird, UT, (May 24, 2017).
- Data-driven experimental design for the identification of extreme event statistics, Banff International Research Station (BIRS), Banff, AB, Canada, (Jan 31, 2017).
- Quantifying the tails of extreme events in intermittent systems, a probabilistic decomposition-based approach, Center for Atmosphere Ocean Science (CAOS) Colloquium, Courant Institute of Mathematical Science, New York University, Host: Prof. Andrew J. Majda, (Nov 3, 2016).
- A probabilistic decomposition-synthesis method for the quantification of rare events in dynamical systems, SIAM Conference on Uncertainty Quantification, Lausanne, Switzerland, (Apr 6, 2016).
- Predicting extreme waves for classing worst-case design loads, ABS University Partnership Symposium, American Bureau of Shipping, Houston, TX, (Aug 4, 2015).
- Probabilistic response of the Mathieu equation excited by correlated parametric noise, 12th International Conference on the Stability of Ships and Ocean Vehicles, Glasgow, UK, (Jun 19, 2015).
- Probabilistic quantification of intermittently unstable systems, Graduate Association of Mechanical Engineers Lunch Seminar, MIT, (May 14, 2015).

Workshops

- Data-Driven Methods for Reduced-Order Modeling and Stochastic Partial Differential Equations, Banff International Research Station (BIRS), Banff, AB, Canada, (Jan 29 – Feb 3, 2017).
- Oberwolfach Seminar: Data Assimilation: The Mathematics of Connecting Dynamical Systems to Data, Oberwolfach Research Institute for Mathematics, Oberwolfach, Germany, (May 15 – 21, 2016).

Poster Presentations

- Analytical Approximation of the Heavy-Tail Structure for Intermittently Unstable Complex Modes, Dynamic Data driven Environmental Systems Science Conference, Cambridge, MA, (Nov 7, 2014).
- Probabilistic description of extreme events in ship rolling under parametric stochastic excitation, Naval Engineering Education Center 2014 Annual Meeting, West Bethesda, MD, (May 19, 2014).

- Probabilistic description of extreme events in ship rolling under parametric stochastic excitation, MIT Water Night 2014, MIT, (Mar. 3, 2014).
- Probabilistic description of extreme events in ship rolling under parametric stochastic excitation, Center for Computational Engineering Student Symposium 2014, MIT, (Mar 13, 2014).
- Probabilistic description of extreme events in ship rolling under parametric stochastic excitation, American Society of Naval Engineers Day 2014, Arlington, VA, (Feb 20, 2014).
- Strain dependent permeability in poroelastic media, Illinois Scholars Undergraduate Research Poster Expo, UIUC, (Apr 11, 2012).

Mentoring

- Victor Biaggi (undergraduate student from 9/17 to 7/18): sequential sampling for extreme events.

Service

Reviewer: NSF Panel Reviewer, SIAM JUQ, Chaos, Journal Ocean Engineering, ISOPE, JuliaCon19, Nonlinear Dynamics, Ships and Offshore Structures, Physics of Fluids

Skills

Computing: Julia, MATLAB, Mathematica, Git, Linux, CAD (Fusion 360), Blender (3D visualization and rendering)

Machining: CNC, basic prototyping

Hobbies: Skiing, Tennis, Hiking (especially mountain scrambles and peak bagging)