
September 2022 CoMFRE Newsletter

Message from the Director

Welcome to another CoMFRE newsletter. The fall semester began over a month ago and we are now in full academic mode. Our students are back and new students are starting their research. We look forward to sharing the student research with you at our upcoming student poster competition during our Annual Meeting (Oct. 24-25). Details of the meeting are below, and we look forward to seeing you in Ames for our first in-person meeting since 2019.

With Fall upon us, there are many multiphase flows to observe, from grain harvest to leaves falling to the inevitable snow flying. Enjoy them all.



Theodore (Ted) J. Heindel
Director, Center for Multiphase Flow
Research and Education
University Professor
Bergles Professor of Thermal Sciences



2022 CoMFRE Annual Meeting

The 2022 CoMFRE Annual Meeting will take place on October 24-25, 2022. The meeting will begin with a student poster contest, reception, and dinner at 6 pm on Monday, October 24, in the ISU Memorial Union. The Tuesday, October 25 session is also open to all attendees and will begin with coffee and pastries at 7:30 am and end by 2 pm. In addition to presentations and a poster session, there will be ample opportunities for networking and interaction among industry and government representatives, faculty, students, and postdocs. Please find the agenda and registration information [here](#).

Upcoming CoMFRE Seminar

Dr. Malissa Lightfoot

October 20, 2022, 9:00 AM 2004 Black Engineering

Tentative Title: "Multiphase flows of interest to AFRL"

Dr. Malissa Lightfoot is the Technical Advisor of the Combustion Devices branch of the Space and Missile Propulsion division at the Air Force Research Laboratory (AFRL/RQRC). As such, she oversees the basic and applied research portfolio for Space Access. Dr. Lightfoot also leads research in the areas of injectors in high-pressure environments, plume-ground interaction, and near-critical thermodynamics. Dr. Lightfoot earned her PhD. From the



University of California at San Diego (UCSD), and studied microgravity droplet combustion at NASA's Glenn Research Center during her post doctoral fellowship. She serves as Vice Chair of ILASS-Americas, an organization devoted to atomization and spray systems, and has served on the editorial board of Atomization and Sprays.

The Air Force Research Laboratory (AFRL) is the Research & Development arm of the Department of the Air Force. AFRL performs research as well as overseeing technology demonstrations in a variety of areas that impact the Air Force. The Combustion Devices branch of the Space and Missile Propulsion division conducts basic and applied research relating to liquid rocket propulsion. Development of new rocket engines has increased appreciably in recent years, but few new engines are fully successful in their initial launches due to the gaps in detailed understanding. AFRL works to fill these gaps and to anticipate and overcome challenges to new developments in the propulsion industry. This talk will overview the areas in which the Combustion Devices branch operates covering disruptive technologies, modeling development, full-scale component studies, and fundamental science. Why specific areas are of interest and the challenges to the research will be described.

New CoMFRE Faculty

Welcome Sidarth (Sid) GS

Sid came to Iowa State after serving as a postdoctoral researcher at Los Alamos National Laboratory, where he worked on modeling mix and burn in multimaterial turbulence and separately on feature based dynamic reconstructions for Richtmyer-Meshkov unstable implosions.

He received his Ph.D. at the University of Minnesota, specializing in computations of hypersonic flows and modeling variable-density subgrid effects relevant to supersonic combustion. He holds an M.S. from Minnesota and a Bachelor of Technology degree from Indian Institute of Technology Kanpur.

Sidarth's interests in multiphase flows range from those encountered in combustion on ablative and reactive surfaces, to interfacial instabilities that lead to multiphase turbulent mixing.'

A full list of CoMFRE faculty can be found [here](#)



CoMFRE and CoMFRE Affiliates in the News

BioMADE project advances bioreactor fermentation processing

A group led by **Rodney Fox**, CoMFRE executive director, is collaborating with Cargill and Genomatica to scale-up bioreactor fermentation processes. The award was [announced at the White House](#) Summit on the National Biotechnology and Biomanufacturing Initiative. The full story can be found [here](#).

Cyclone Engineers to advance aerosol jet printing research with NSF grant

CoMFRE affiliates **Ethan Secor** and **Adarsh Krishnamurthy** are studying how aerosol jet printing can overcome the physical and computational challenges in conformal printing on curved surfaces. The team will combine manufacturing systems with computational control expertise to develop new approaches to using aerosol jet printing applications like printing electronic devices on airplane wings, turbine blades, vehicles, and more. Read more [here](#).

CoMFRE jet atomization project captures unseen physics

In a project led by CoMFRE affiliate faculty **Baskar Ganapathysubramanian** and **Adarsh Krishnamurthy**, graduate student Kumar Saurabh developed new jet atomization algorithms to accurately capture the formation of droplets and necessary physics. “This project gives you a new set of algorithms that people can use to simulate multiphase flow – and break down unseen physics that you cannot just capture through experiments,” Saurabh said. Full story found [here](#).

A project and a conference: Insight to FSI PDE modeling behavior

CoMFRE affiliate **Pelin Guven Geredeli** is generating new analysis techniques for fluid-structure interactions models that include Stokes and Navier-Stokes equations. The work has applications in understanding flows in the heart, airline icing, and more. More information can be found [here](#).

Faculty Honors and Awards

Building a World of Difference Faculty Fellowship in Engineering

Todd Kingston, assistant professor of mechanical engineering. Established by

Black & Veatch in honor of Len ('71 BS Civil Engineering) and Julie ('71 BS Home Economics Education) Rodman

D.R. Boylan Eminent Award for Research

Ted Heindel, Bergles Professor in Thermal Science, University Professor of mechanical engineering, and director of the Center for Multiphase Flow Research and Education

Manorama and Shyam Bahadur Professorship in Mechanical Engineering

Pranav Shrotriya, professor of mechanical engineering.

Outstanding Achievement in Teaching – Tenure

Chris Rehmann, Joel A. and Judy Cerwick Professor of Environmental Engineering, associate professor of civil, construction and environmental engineering

Patent Award

Dennis Vigil, professor of chemical and biological engineering, "*Personal protective anti-viral face mask*"

Recently Funded Research Awards

Feel free to contact the PI directly if you have any questions on the projects below.

- "Exploiting Hydrodynamic Oscillations of Oscillating Heat Pipes for Thermomagnetic Power Generation from Low-grade Waste Heat" **Todd Kingston** and Jun Cui; Funding Agency: NASA; New Funding Amount: \$100,000
 - "Developing a Systematic Tool for Sontaminant Protection and Reducing Exposure to Contaminated PPE" **Guowen Song, Travis Sippel**, Lizhi Wang, Zhengyuan Zhu, and Rui Li; Agency: FEMA Amount \$1.57 Million
 - "Rational Fermentation Scaleup: Response of Metabolic Kinetics to Hydrodynamic Variability" **Rodney Fox, Alberto Passalacqua, Theodore Heindel**, Zengyi Shao, and **Dennis Vigil**; Funding Agency: BioMADE; New Funding Amount: \$2,341,700 total project value; \$1,350,790 to ISU
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Recent Journal Publications

Note that CoMFRE affiliates are identified by **bold** names

- Belekar, V.V., Nere, N.K., Sinha, K., **Passalacqua, A., Heindel, T.J., Subramaniam, S.** "A Comparison of Mixture and Separated-Phase Models of Heat Transfer in a Stationary Wet Granular Bed," *International Journal of Heat and Mass Transfer*, 197, Paper 123275, 2022.
<https://doi.org/10.1016/j.ijheatmasstransfer.2022.123275>

- Burtnett, T.J., Morgan, T.B., Dahlstrom, T.C., and **Heindel, T.J.**, “Near-field Observations of a Coaxial Airblast Atomizer under Elevated Ambient Pressure,” *Atomization and Sprays*, 32:9 39-55, 2022.
 - Sashittal, P., Chiodi, R., Morgan, T.B., Desjardins, O., **Heindel, T.J.**, and Bodony, D.J., “Modal Analysis and Interface Tracking of Multiphase Flows using Dynamic Mode Decomposition,” *International Journal of Multiphase Flow*, 157, Paper 104198, 2022.
<https://doi.org/10.1016/j.ijmultiphaseflow.2022.104198>
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Our email address is: comfre@iastate.edu

Visit our website: <https://comfre.iastate.edu/>

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