June 2023 CoMFRE Newsletter

Message from the Director

Welcome to our June 2023 Newsletter. Summer is here and campus has slowed down. We at CoMFRE have not slowed and are planning our annual meeting, to be held October 23-23, 2023. Many faculty are also playing catch-up, from writing papers and proposals to working with their graduate students on their multiphase flow research. They are also attending conferences and meeting with collaborators.

Multiphase flows are also popular over the summer, from kids splashing in water to eating flavor-infused snow cones to walking through sand to watching fireworks! Take a moment to recognize the multiphase flows around you and how they impact your life. And enjoy the rest of the summer!

Ted

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

Save the Date - 2023 CoMFRE Annual Meeting

The 2023 CoMFRE Annual Meeting will take place on October 23-24, 2023 at the Iowa State Alumni Center. Confirmed speakers include representatives from Argonne National Lab, John Deere, and Iowa State. Additional speakers are being confirmed. More information to follow.

New CoMFRE Leadership Team Member

Every year the composition of our CoMFRE Leadership Team changes.

CoMFRE is organized into a 6-member leadership team, where 3 members are permanent and 3 serve rotating 3-year terms. The current leadership team includes me (Director), Alberto Passalacqua (Associate Director), and Rodney Fox (Executive Director) as the three permanent members, and rotating members Hui Hu (finishing his 3rd year), Nicole Hashemi (finishing her 2nd year), and James Michael (finishing his 1st year).

Hui Hu is rotating off the leadership team and we thank him for his valuable contributions. Mehari Tekeste, Associate Professor of ABE, was selected by CoMFRE faculty members to be the newest member of the CoMFRE Leadership Team. Mehari's current research areas include simulation of machine performance at the machine-soil-crop interface, and precision agriculture technology development for tillage and soil compaction management. Mehari, welcome to our team!

CoMFRE and CoMFRE Affiliates in the News

Fynn Reinbacher fires up oxy-fuel combustion project in Gas Turbine Industrial Fellowship

Fynn Reinbacher, a Ph.D. candidate in mechanical engineering and a graduate assistant in CoMFRE affiliate **James Michael's** research group, was a Gas Turbine Industrial Fellow at Southwest Research Institute. Reinbacher focused on three projects in oxy-fuel combustion, contributing unique multi-phase flow research expertise he developed at Iowa State. Read more here

CoMFRE affiliate awarded distinguished professor title

Kejin Wang, professor in geotechnical and materials engineering, says doing what you love is the key to success. Her unwavering passion for her field has earned her the title of distinguished professor, the first woman to ever receive this honor in the Department of Civil, Construction and Environmental Engineering. The full story can be found here.

The Conversation: Ted Heindel, fluid flow expert, on why peanut butter is a liquid and the physics of this and other unexpected fluids.

When news spread that the TSA recently confiscated a jar of peanut butter under the rules against carrying on liquid over the 3.4-ounce limit, people weren't nuts about the TSA's decision.

But it made sense to fluid-flow experts, including CoMFRE director **Ted Heindel.** He was asked to write about what makes peanut butter a delicious liquid in The Conversation - and more than 60,000 people have read the story about the physics of unexpected everyday fluids.

Faculty Honors and Awards

Jean D'Alembert Senior Professor Chair Award

Rodney Fox, executive director of CoMFRE, Anson Marston Distinguished Professor in Engineering and Hershel B. Whitney Professor, Global Initiatives, has been selected for the Jean D'Alembert Senior Professor Chair, University of Paris-Saclay, France

Promotions

Jaime Juarez, Department of Mechanical Engineering, promoted to Associate Professor with tenure.

Recently Funded Research Awards

- "Comprehensive Eulerian models for electrostatic phenomena in polydisperse gas-particle flows," PI: **Alberto Passalacqua**, Co-PI: **Manjil Ray**. Funding Agency: National Science Foundation; New Funding Amount $409,993

Recent Journal Publications

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

- Bryngelson, S.H., **Fox, R.O.,** and Colonius, T. "Conditional moment methods for polydisperse cavitating flows," *Journal of Computational Physics* 477, 111917 (2023).
- **Fox, R.O.,** Laurent, F., and **Passalacqua, A.,** "The generalized quadrature method of moments," *Journal of Aerosol Science* 167**,**106096 (2023).
- Ilgun, A. D., **Passalacqua, A**., and **Fox, R.O**., "A computational-fluid-dynamics model for particle-size evolution in the presence of turbulent

mixing," *Chemical Engineering Science* 279 (5), 118961 (2023).

- Madadi-Kandjani, E., **Passalacqua, A**., and **Fox, R.O.** "Investigation of the turbulent mixing inside the confined impinging jet mixer using the Fokker-Planck mixing model," *Chemical Engineering Science* 273, 118634 (2023).
- Nadeem, N., Jamdagni, P., **Subramaniam, S**., Nere, N.K., and **Heindel, T.J**., "Assessing solid particle mixing using X-ray radiographic particle tracking," *Chemical Engineering Research and Design*, 194, pp. 563-572, 2023. https://doi.org/10.1016/j.cherd.2023.05.003
- Nadeem, N., Jamdagni, P., **Subramaniam, S.**, Nere, N.K., and **Heindel, T.J.**, "Non-invasive particle-scale investigation of the effects of blade Speed and Particle Properties on Mixture Homogeneity Evolution using X-ray CT," *Chemical Engineering Science*, 276, Paper 118766, 2023. https://doi.org/10.1016/j.ces.2023.118766.
- Pillers, R.A., and **Heindel, T.J.**, "Plume analysis of plunging liquid jets with floor interactions using stereographic backlit imaging," *Journal of Flow Visualization and Image Processing*, 30:4 pp. 1-23, 2023. DOI: 10.1615/JFlowVisImageProc.2022044942
- Soria-Verdugo, A., Cano-Pleite, E., **Passalacqua, A.**, and **Fox, R.O.** "Effect of particle shape on biomass pyrolysis in a bubbling fluidized bed," *Fuel* 339, 127365 (2023).
- Vu, L., Machicoane, N., Li, D., Morgan, T.B., **Heindel, T.J.**, Aliseda, A. Desjardins, O., "A computational study of a two-fluid atomizing coaxial jet: Validation against experimental back-lit imaging and radiography and the influence of gas velocity and contact line model," *International Journal of Multiphase Flow*, 167, Paper 104520. https://doi.org/10.1016/j.ijmultiphaseflow.2023.104520

Recent Conference Publications and Presentations

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

- Ahasan, K., Schnoebelen, N., Shrotriya, P., and **Kingston**, **T.A.**, "Aerosolized particle collection and enrichment using stratified two-phase microfluidics for biothreat sensing," SPIE Defense + Commercial Sensing – Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) Sensing XXIV Conference, Orlando, FL, 2023.
- Almeras, E., Masbernat, O., Risso, F., and **Fox, R.O.** "Second and third moments of liquid and solid phase velocity distributions in homogeneously fluidized inertial suspensions," ICMF 2023, Kobe, Japan.
- Farsoiya, P. K., Deike, L., **Fox, R.O**., Vonka M., and Daiss, A. "Direct-numerical simulation of droplet breakup in homogeneous isotropic turbulence", ICMF 2023, Kobe, Japan.
- Knuerr, J.J., Dahlstrom, T.C., and **Heindel, T.J.**, "Characterizing sprays using high-speed X-ray imaging and image analysis," 2023 National Conference on Undergraduate Research (NCUR), UW-Eau Claire, Eau Claire, WI, April 13-15, 2023

- Ogata, Y., **Fox, R.O.,** Abdelsamie, A., Thévenin, D., Franzelli, B. “Direct numerical simulation of TiO_2 nanoparticle flame synthesis in homogeneous isotropic turbulence,” European Combustion Meeting (ECM 2023), Rouen, France.
- Posey, J. W., **Fox, R.O**., and Houim, R. W. “Simulations of explosively dispersed polydisperse aluminum powders,” 23rd Biennial Conference of the APS Topical Group on Shock Compression of Condensed Matter (SHOCK23), 2023, Chicago, IL.
- Posey, J. W., Houim, R. W., and **Fox, R.O.** “Development of an Eulerian polydisperse multiphase flow model,” ICMF 2023, Kobe, Japan.

Recent Invited Presentations:

- **Fox, R.O.:**
  - “Eulerian two-fluid models for high-speed polydisperse gas–particle flow,” Invited Lecture, 35th Computational Fluid Mechanics Seminar, Paris, France.
  - “A kinetic-based, multiscale Eulerian model for polydisperse multiphase flows,” Invited Seminar, D’Alembert Laboratory, Université de Pierre et Marie Curie, Paris, France.
  - “Recent advances in well-posed Eulerian models for polydisperse multiphase flows,” Plenary Lecture, 11th International Conference on Multiphase Flows (ICMF-2023), Kobe, Japan.
  - “Recent advances in quadrature-based moment methods,” Invited Lecture, Workshop on Moment Methods in Kinetic Theory IV Workshop, Karlsruhe, Germany.
  - “Eulerian two-fluid models for high-speed polydisperse gas–particle flow,” Invited Lecture, CEA-DAM, Paris, France.
  - “Eulerian two-fluid modeling of high-speed polydisperse gas–particle flow,” Invited Seminar, CORIA Laboratory, Rouen, France.
  - “A kinetic-based, multiscale Eulerian model for polydisperse multiphase flows,” Invited Seminar, MSME Laboratory, Champs-sur-Marne, France.
  - “Kinetic-based, multiscale Eulerian models for polydisperse multiphase flows,” Invited Lecture, 2023 International Symposium on Multiphase CFD for Sustainable Engineering, Shanghai Institute for Advanced Study, Zhejiang University, Shanghai, China.
  - “Turbulence modeling of compressible disperse multiphase flows,” Keynote Lecture, IUTAM Symposium on Turbulent Structure and Particles-Turbulence Interaction, Lanzhou University, Lanzhou, China.
  - “Kinetic-based, multiscale Eulerian models for polydisperse multiphase flows,” Invited Lecture, Guangdong Technion - Israel Institute of Technology, Shantou, China.

Student Honors and Awards

Recent Degrees Granted to Students Working on Multiphase Projects

- Barlev Raymond Nagawkar, Ph.D., Dissertation title: “Analysis of biomass mixing and reactions in bidisperse gas-solid flows using Eulerian multiphase models,” Advisor: **Alberto Passalacqua**.
- Krishnamurthy Ravichandar. Ph.D., Dissertation title: “Droplet Breakage in Turbulent Flow: Experiments and Theory,” Advisors: **Michael Olson** and **Dennis Vigil**
