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2022 Newsletter — Scientific Computing and Flow Physics Laboratory

SCFPL this Year

PhD Students: Eunhye An, Erin Burrell, Griffin Cearley, Sonya Dick, Codie Fiedler-Kawaguchi (co-advised by Xun Huan), Baudouin Fonkwa, Minki Kim, Nick Lucido (advised by S. Ceccio), Kevin Ma, Michael Wadas, William White

MS Students: Mizuho Takayama

UG Students: Jiashu Han, Eric Hersey, Kimberly Kerr, David Wang, Xinyu Xie, Chenhao Zhu

Post-docs: Mani Balakrishna, Ziyang Huang

Admin: Diane Brouwer

PI: Eric Johnsen

Research Highlights

- *Multiphase flows.* We are developing a theory for energy transfer during bubble growth and collapse to better understand cavitation-induced damage to both soft and hard materials. We are also investigating potential damage by high-speed droplet impact in the context of hypersonics.
- *High-energy-density physics.* We are investigating vortex rings ejected from shocked interfaces and their stability. We are also examining the detailed physics of x-rays and lasers interacting with matter. Additionally, we are using perturbed interfaces to determine material properties at high pressures.
- *Turbulence.* We are investigating mixing at steep gradients in turbulence intensity in different geometries (planar, cylindrical).
- *Scientific Computing.* We are developing Discontinuous Galerkin methods for massively parallel, high-resolution simulations of the multiphase Navier-Stokes equations, with extension to radiation-hydrodynamics. We are also pursuing Phase-Field models to improve the accuracy of the representation of interfaces.

This past year, articles with contributions from our group appeared in *J. Fluid Mech.*, *Phys. Plasmas*, *AIAA J.*, and *Tribol. Int.* The group had good representation at the APS-DPP and APS-DFD meetings, and also presented at ICNMMF, IWPCTM, AGU fall meeting, the Omega User Group meeting.

We started several new projects this year:

- A theoretical/computational framework to measure SiO₂ and MgO viscosity at high pressure (DOE/NNSA, collaboration with Johns Hopkins and LLNL)
- A multiscale, physics-based approach for blast and blunt traumatic brain injury prediction and prevention (ONR, collaboration with U. Wisconsin and Robert Morris U.)
- Flow characterization in novel needle designs to enhance the delivery of high-viscosity large-volume therapeutics (Merck)

We take this opportunity to acknowledge the invaluable contributions from our research collaborators this past year: C. Franck (Wisconsin), R. Carlsen (Robert Morris U.), P. Bardet (George Washington U.), J. Wicks (Johns Hopkins U.), J. Eggert, M. Millot, P. Porazik, I. Lopez, B. Perfect, M. Patel, M. Sherlock, W. Farmer (LLNL), E. Dominguez-Ontiveros and C. Barbier (ORNL), Sahab Babae (Merck), X. Huan, S. Ceccio, H. LeFevre, C. Kuranz, R. P. Drake, K. Maki (U-M), as well as former group members S. Shinde (Aptiv), M. Rodriguez (Brown U.), and C. Kim

(Samsung). We are also grateful to our sponsors for their support: ONR, DOE/NNSA, LLNL, ORNL, LLE, Merck and MICDE, as well as ALCF, OLCF, and XSEDE for computing resources.

Group Happenings this Year

Welcome to this year's new members to the group:

- Post-doctoral scholar Mani Balakrishna
- Undergraduates Kimberly Kerr, Chenhao Zhu, Xinyu Xie, David Wang

Congratulations to Minki Kim and Griffin Cearley on defending their PhD! Minki started a postdoc at Brown University and Griffin took a research position at Sandia National Laboratories. Upon the completion of his postdoc, Mani started at Corning. After completing his BS, Jiashu started as a PhD student in Applied Math at U-M. This past summer, William completed an internship at LLNL working on MHD.

This year, our professional development series involved a summer-long series of lectures on math and fluid mechanics—the foundation of what we do in the group. Unfortunately, we ran out of time so could not cover computation.

The group came up with a concept for quarter zips and jackets with a new logo—thanks to William for coordinating! You'll be able to catch some of us sporting this swag at conferences.



Congratulations

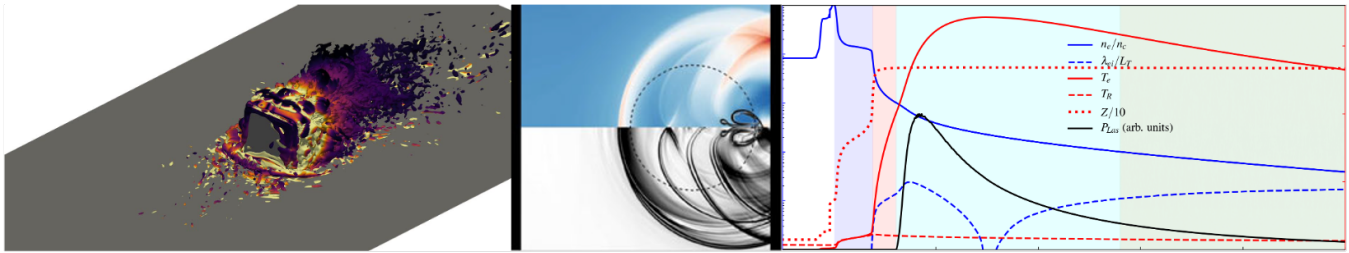
- Michael Wadas, 2022 IWPCTM Best Presentation by a Student and 2022 Rackham Predoctoral Fellowship.
- William White, 2022 MICDE Graduate Fellowship.

Alumni News

- Aditya Nair (U. Nevada Reno) received a DOE Early Career Award.
- Marc Henry de Frahan (NREL) received a 2022 APS/DFD Milton van Dyke Award.
- Shaowu Pan started this Fall as Assistant Professor in the Mechanical, Aerospace, and Nuclear Engineering department at Rensselaer Polytechnic Institute.
- Seth Norberg started this Fall as Associate Professor in the Engineering Technology Department at Northern Michigan University.

- Renaud Gaudron started as a data scientist at Aviva.

Apologies if we missed some of our alumni's achievements—please let us know if this is the case. And do stay in touch, we want to hear about you!



*Selected artwork from this year's SCFPL papers
(Siddhesh Shinde, Mauro Rodriguez, Kevin Ma)*

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