

## 2018 Newsletter

### Scientific Computing and Flow Physics Laboratory—University of Michigan

#### SCFPL this year:

Post-docs: Shahab Beig, Mauro Rodriguez

PhD Students: Eunhye An, Griffin Cearley, Philip Johnson, Minki Kim, Kevin Ma, Lauren Mancina, Kazuya Murakami, Samuel Pellone, Suyash Tandon, Michael Wadas

MS Students: Sandra Edward, Susmit Joshi

PI: Eric Johnsen

#### Research highlights:

- *Cavitation-induced damage.* In basic studies of collapsing bubbles in water, we now have a better understanding of the modes of energy transfer and dissipation, as well as the resulting non-spherical dynamics when the collapse occurs near a rigid wall, another bubble, or a free surface. As we apply this understanding to cavitation in soft matter (e.g., human tissue), the relative importance of the various mechanisms changes.
- *High-energy-density physics.* We seek to better understand the mechanics of and energy transfer at material interfaces. We are investigating the late-time growth of hydrodynamic instabilities using vorticity dynamics modeling, as well as the extent to which intense radiation generally affects interfacial dynamics. We are also studying electron thermal transport in materials due to laser irradiation.
- *Turbulence.* We are investigating mixing at regions of sharp gradients in turbulence intensity, as well as the role of passive vortex generators embedded in a turbulent boundary layer on the modulation of separated regions downstream of a ramp.
- *Scientific Computing.* We are developing high-order accurate, Discontinuous Galerkin methods for high-fidelity (LES, DNS) simulations of the compressible Navier-Stokes equations on unstructured meshes. This framework enables the exploration of approaches addressing exascale computing challenges related to faults and data movement. We have also been extending our interface-capturing scheme to handle (visco)elastic problems.

This past year, articles with contributions from our group appeared in J Fluid Mech, Phys Rev Fluids, J Mech Phys Solids, IEEE Trans Ultrason Ferr Freq Control, Phys Med Biol, Ultrasound Med Biol. Stay tuned for upcoming articles in J Comput Phys, J Appl Phys D: Appl Phys, and Shock Waves in 2019. Our group presented at APS-DPP, APS-DFD, AVIATION, WCCM, CAV, National MD/PHD Student Conference, laser user group meetings (NIF/JLF, Omega).

We take this opportunity to acknowledge the invaluable contributions of our collaborators on these studies: Christian Franck (Wisconsin), David Henann (Brown), Tim Colonius (Caltech), Charlotte Barbier (ORNL), Mehul Patel (LLNL), Marc Henry de Frahan (NREL), H.T. Huynh (NASA Glenn), Keita Ando (Keio U.), Jean-Pierre Franc (U. Grenoble), Steve Ceccio, Paul Drake, Carolyn Kuranz, Mark Kushner, Kevin Maki, Ken Powell, Venkat Raman, Zhen Xu (U-M). We also thank our sponsors for their support: ONR, LLNL, ORNL, DOE, NSF, and NIH, as well as ALCF, OLCF, Blue Waters and XSEDE for computing.

#### People:

Our group welcomed several members. MD/PhD student Lauren Mancina started the PhD portion of her degree in our group this spring. MS students Susmit Joshi and Sandra Edward joined our group this year.

We celebrated three PhD thesis defenses this year: Shahab Beig, Mauro Rodriguez, and Siddhesh Shinde. Congratulations to all! Siddhesh joined Aptiv as a Data Scientist Engineer, while Mauro and Shahab remain at U-M as postdocs for the time being.

The group hosted Kyosuke Akiyama (Hiroshima U.) and Tomoki Kondo (Keio U.) for visits this year. Kyosuke studied Discontinuous Galerkin Methods while Tomoki investigated shear flows produced by bubbles collapsing near a rigid wall.

Kevin Ma spent the summer at LLNL working with Dr. Mehul Patel on electron thermal transport modeling. Phil Johnson spent the summer at NASA Glenn working with Dr. H.T. Hyunh on analysis of high-order methods.

Michael Wadas was awarded an NNSA Stewardship Science Graduate Fellowship this year, and received poster awards at the MIPSE and Engineering Graduate Symposia.

#### **Alumni news:**

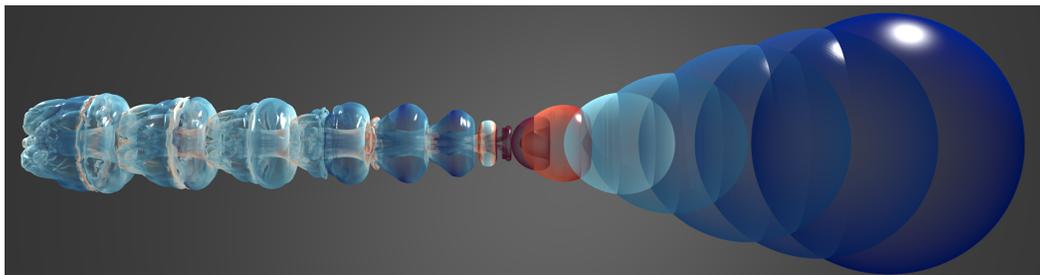
- Dr. Pooya Movahed started a new position at Siemens PLM Software.
- After receiving his PhD from Ecole Centrale, Dr. Renaud Gaudron started a postdoc at Imperial College.
- Matt Warnez started his MS at U. St. Thomas.
- After receiving his PhD from Florida State U., Dr. Aditya Nair started a postdoc at U. Washington.

To all SCFPL alumni and friends: please stay in touch!

#### **Other newsworthy items:**

Our group coordinated fluid-mechanics-based demos in collaboration with the U-M Museum of Natural History staff for visiting middle school students. At the APS-DPP meeting, Griffin showcased his Kelvin-Helmholtz/Rayleigh-Taylor tube at the MIPSE booth at the Introduction to Plasma Science Expo.

We held the first SCFPL symposium this past September. All group members (as well as a few members of the extended group) gave research presentations, with Dr. Brandon Patterson giving the keynote lecture and being recognized as outstanding alumnus. A big thanks to Phil Johnson for organizing the event!



Streak-image of a bubble collapsing near a rigid surface (S. A. Beig, 2018).

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