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## 2025 Year in Review — Scientific Computing and Flow Physics Laboratory

### SCFPL this Year

PhD Students: Ellie Anderson-Zych, Erin Burrell, Codie Fiedler-Kawaguchi (co-advised by X. Huan), Baudouin Fonkwa Kamga, Bjorn Kierulf, Madeline Keller, Curtis Maxon (co-advised by K. Duraisamy), William White  
MS Students: Xinyu Xie  
UG Students: Jerry Huang, Katarina Jevtic, Elliot Vander Roest, Scott Cheung, Christopher Fan (U. Wisconsin)  
Post-docs: Stephen DiIorio, Erin Burrell  
Admin: DeLynne Lahtinen  
PI: Eric Johnsen

### Research Highlights

Our group members have worked on problems across a variety of fields this year:

- *Multiphase flows:*
  - We are extending our models for cavitation in soft matter to predict traumatic brain injury due to blasts and directed energy.
  - We are investigating potential damage by high-speed droplet impact to solid surfaces in the context of hypersonics.
  - We are conducting fundamental studies of oblique shock-interface interactions.
- *High-energy-density physics:*
  - We are investigating vortex-core instabilities as a pathway to three-dimensional structure formation during the interaction of a shock with a nominally 2D geometry.
  - We are developing models to study photoionization fronts and ablation fronts.
- *Scientific Computing:*
  - We are developing Phase-Field models to improve the accuracy of the representation of material interfaces and methods for fully coupled fluid/solid problems.
  - We are investigating numerical errors at mesh boundaries in the context of hp adaptive methods.
  - We are developing approaches for verification of interface-capturing schemes.
  - We are applying optimal experimental design to material characterization in shocked systems.

This year, articles with contributions from our group appeared in Physical Review Fluids, Physical Review E, Physical Review B, Journal of Computational Physics, and Journal of Fluid Mechanics:

- M. Kim, S. A. Beig and E. Johnsen, Energy concentration and release during the inertial collapse of a spherical gas cavity in a liquid.
- M. J. MacDonald, H. A. Scott, K. H. Ma, S. R. Klein, T. F. Baumann, R. W. Falcone, K. B. Fournier, C. M. Huntington, E. Johnsen, C. C. Kuranz, E. V. Marley, A. M. Saunders, M. P. Springstead, P. A. Sterne,

M. R. Trantham and T. Doppner, Demonstration of x-ray fluorescence spectroscopy as a sensitive temperature diagnostic for high-energy-density physics experiments.

- T. M. Perez, S. Dick, R. F. Smith, P. M. Celliers, J. H. Eggert, S. J. Ali, E. Johnsen and J. K. Wicks, Low viscosity of solid MgO at high pressures and strain rates measured using laser-driven Richtmyer-Meshkov instabilities.
- W. J. White, Z. Huang and E. Johnsen, A high-order discontinuous Galerkin method for compressible interfacial flows with consistent and conservative Phase Fields.
- Z. Huang and E. Johnsen, Bound preservation for the consistent and conservative Phase-Field method for compressible single-, two-, and N-phase flows.
- S. Bhola, M. Rodriguez, S. A. Beig, C. N. Barbier and E. Johnsen, Inertial collapse of a gas bubble in a shear flow near a rigid wall.

The group had good representation at the APS-DPP and APS-DFD meetings, and also presented at ICMF and AIAA SCITECH and AVIATION. We also participated in the PANTHER workshop.

We started two new projects this year:

- Center for Prediction, Reasoning & Intelligence for Multiphysics Exploration (C-PRIME), NNSA, Venkat Raman PI
- Dynamics of vortex ultrasound enhanced acoustic cavitation, NSF, Chengzhi Shi PI

We take this opportunity to acknowledge the invaluable contributions from our research collaborators this past year: C. Franck and Alice Fawzi (Wisconsin), R. Carlsen (Robert Morris U.), T. Perez (Carnegie Institute), J. Wicks (Johns Hopkins U.), B. Perfect, H. Beydoun, R. Smith, J. Eggert, P. Celliers, M. MacDonald (LLNL), E. Merritt, A. Rasmus, J. Dolence (LANL), X. Huan, C. Kuranz, K. Duraisamy, V. Raman, C. Shi (U-M), as well as former group members S. Bhola (U. Michigan), M. Kim (Brown U.), S. A. Beig (Intel), M. Rodriguez (Brown U.), and Z. Huang (U. Alabama). We are also grateful to our sponsors for their support: ONR, DOE/NNSA, NSF, and LANL, as well as OLCF and ACCESS for computing resources.



## Group Happenings this Year

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

- Undergraduates Jerry Huang, Katarina Jevtic, Scott Cheung, Elliot Vander Roest

Congratulations to Erin Burrell, William White, and Baudouin Fonkwa Kamga on defending their PhD! Long-time group affiliate Nick Lucido also defended his PhD this year. Stephen DiIorio took a position at Lockheed Martin, and Erin Burrell at GE Aviation.

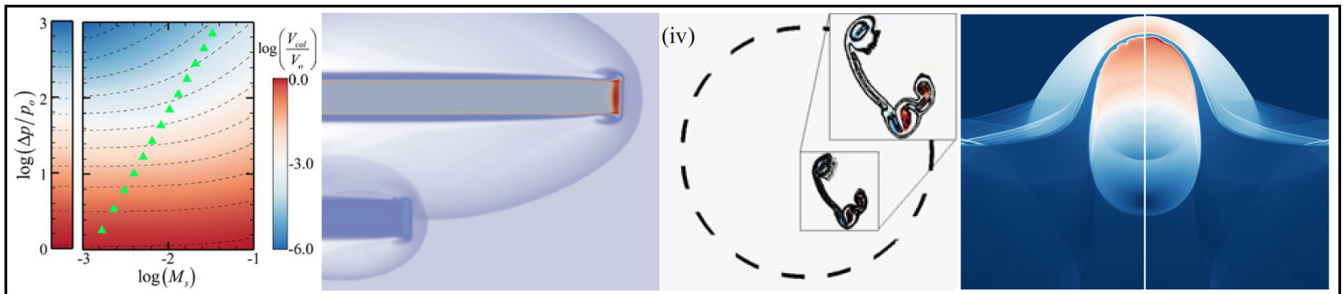
**Congratulations to group members on the following awards:**

- Eleanor Anderson-Zych, 2025 Computational Acoustics Early Career Presenter Competition, Acoustical Society of America
- Michael Wadas, 2025 Andreas Acrivos Dissertation Award, American Physical Society
- Eleanor Anderson-Zych, 2025 Webinar Speaker (invited), Acoustical Society of America

**Alumni News:**

- Shaowu Pan was a recipient of the Google Research Scholar Program.
- Yasmina Elmore received her Master’s degrees from ENSTA Paris and Stanford.
- Suyash Tandon started a new position at Reditus Space.

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  
(M. Kim, Z. Huang, S. Bhole, W. White)*

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