

Boulder Fluid and Thermal Sciences Seminar Series



Monday, April 16, 2018

10:00am-11:00am (refreshments at 9:45am)

Clark Conference Room (ECAD 150)

Engineering Center Administration Wing, University of Colorado, Boulder

Including Full Chemistry in Simulations of Turbulent Reacting Flows: Flow-Chemistry Coupling via Flamelet Libraries Based on Elemental Mixture Fractions

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Real turbulent reacting flows typically involve complex chemical kinetics, with dozens of chemical species undergoing hundreds of simultaneous reactions in an underlying complex turbulent flow. However this creates an unacceptable computational burden, so most such simulations are instead approximated by just a handful of chemical species undergoing a small number of reactions, even though this can greatly limit the fidelity of the simulations. To allow a more accurate approach, formal methods have been developed based on the conservation of atoms under chemical reactions that use the “elemental mixture fraction” to rigorously replace the dozens of chemical species transport equations involving hundreds of reaction terms with a single conserved scalar transport equation. For both equilibrium and non-equilibrium chemistry, this approach allows rigorously-developed “flamelet libraries” to be coupled to local values of the conserved scalar and the scalar dissipation rate from the single conserved scalar transport equation, including full chemical kinetics and even differential diffusion of chemical species. This coupling accounts for heat release effects on the flow and mixing processes as well as on transport coefficients, enabling high-fidelity simulations of complex turbulent reacting flows with full chemistry at far lower computational cost than is possible by approaches based on reduced chemistry models.

Biography: Werner J.A. Dahm has since 2010 been the ASU Foundation Professor of Mechanical and Aerospace Engineering at Arizona State University, where he leads the Laboratory for Turbulence and Combustion and is the Founding Director and Chief Scientist of the Security and Defense Systems Initiative. He is also Emeritus Professor of Aerospace Engineering at the University of Michigan, where he served on the engineering faculty for 25 years.

Previously he was the Chief Scientist of the U.S. Air Force in Headquarters Air Force, serving in the Pentagon as the direct science and technology advisor to the Secretary of the Air Force and the Air Force Chief of Staff. He has served on the Air Force Scientific Advisory Board since 2005, including as Chair of the Board from 2014-2017, and has served on numerous task forces of the Defense Science Board. He has also served on advisory boards for Lawrence Livermore National Laboratory and NASA, and in numerous defense-related reviews and advisory roles.

Dr. Dahm is a Fellow of the American Physical Society and the American Institute of Aeronautics and Astronautics. He is an author of over 200 refereed technical articles, conference papers, and technical publications, a holder of six U.S. and international patents, and has given over 260 technical presentations, including over 190 invited, plenary, and keynote lectures worldwide, on topics dealing with mechanical and aerospace engineering and defense science.

