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Swanson School of Engineering
University of Pittsburgh

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Quantum Information and Deep Learning for Turbulent Combustion Modeling & Simulation

Quantum Information Science (QIS) and Artificial Intelligence (AI) are having a dominant influence in many aspects of life in industrial societies. The importance of these fields to the global economy and security are very well recognized, promoting the rapid growth of the related technologies in the upcoming decades. This growth is fueled by very large investments by many governments and leading industries. An arena in which QIC and AI are being promoted to play a more significant role is combustion. The fact is that combustion provides the largest portion of the energy needs in the world, despite all of the dedicated efforts towards the development of alternative and/or sustainable energy resources. This situation will likely remain the same within the foreseeable future.

This lecture is focused on recent work in which use is made of modern developments in Quantum Computing (QC), and Deep Learning (DL) & Machine Learning (ML) to tackle some of the most challenging problems in turbulent combustion. The computational approach is via a stochastic model termed the Filtered Density Function (FDF). This model, originally developed by this lecturer, provides one of the most systematic means of describing the unsteady evolution of reactive turbulence. It is demonstrated that, if devised intelligently, DL/ML can aid in developments of high fidelity FDF closures, and QC provides a significant speed-up over classical FDF simulators.

Dr. Peyman Givi is Distinguished Professor and James T. MacLeod Professor of Mechanical Engineering and Petroleum Engineering at the University of Pittsburgh. Previously he held the position of University at Buffalo Distinguished Professor of Aerospace Engineering. He has also had frequent visiting appointments at the NASA Langley & Glenn centers, and received the NASA Public Service Medal. He is among the first 15 engineering faculty nationwide who received the White House Presidential Faculty Fellowship from President George H.W. Bush. He also received the Young Investigator Award of the Office of Naval Research, and the Presidential Young Investigator Award of the National Science Foundation.

Dr. Givi is currently the Deputy Editor of *AIAA Journal* (2010-present). He has also served as: Associate Editor of *AIAA Journal* (1998-2009), *Journal of Applied Fluid Mechanics* (2005-present); and Editorial Advisory Board Members of *Computers & Fluids* (1993-present), and *Progress in Energy and Combustion Science* (1996-2004). Professor Givi is Fellow of AAAS, AIAA, APS and ASME. He received Ph.D. from the Carnegie-Mellon University (PA), and BE from the Youngstown State University (OH) where he was named the Distinguished Alumnus.

For further information about this Lecture, please contact Ms. Meagan Lenz (MEL171@pitt.edu).