HYPERSONIC INSIGHTS

Why Academic & DoD Partnerships are Essential to Winning the Hypersonic Arms Race

To start, please tell us a bit about yourself. What is your area of expertise, what sort of research/work do you do, and, broadly speaking, how does it relate to the development of hypersonic systems?

My general area is thermal fluid sciences, including fluid mechanics and heat transfer. I am and have been involved in research involving microfluidics, including micro pumps, and micro transport at very small scales. I also work in the area of fractionation, as well as electronic cooling, and convective heat transfer augmentation. My convective heat transfer research involves work both at very low speeds and at high speeds, including supersonic and hypersonic flows.

Of particular interest for hypersonic and supersonic flows are thermal transport and heat transfer phenomena. This is an area where there are very, very few publications available in the open literature, and as a result, there are a plethora of wonderful opportunities for new understanding of physics, and for new, innovative research developments.

A conversation with.....



Dr. Phillip Ligrani Eminent Scholar, Propulsion University of Alabama-Huntsville



In the past year or so, within the Propulsion Research Center of the University of Alabama in Huntsville, we've been doing some work in regard to control and manipulation of different types of shock waves within supersonic flows. We have a number of associated papers that are either under development, submitted, or are about to be published. Associated physical phenomena are fascinating, very complex, and lead to additional, new research questions regarding supersonic and hypersonic flow phenomena.

Are you currently working with the DOD and, if so, could you tell us just a little bit about those projects?

I have had a number of DoD-funded research projects in the past. At present, my colleagues and I are assembling a number of innovative research solutions related to hypersonic fluid flows and hypersonic weapons development, both with and without heat transfer, with several proposals that are under current consideration by the DOD. We're also working to develop several new proposals related to hypersonic flows and supersonic flows, for submission to the National Science Foundation and other non-DoD entities.

Why is it important for the DOD and academia to work together?

The academic environment provides useful resources for the DOD, including new innovative ideas. It's a good avenue of opportunity for the DOD, because a number of academic people have inventive ideas about how to control and manipulate shock waves, and other flow effects, in supersonic and hypersonic flows. For example, supersonic flows and hypersonic flows are very sensitive to flow and thermal boundary conditions. As such, potentially game-changing boundary condition modification opportunities are available that have not been pursued in a significant manner by the DOD.

Are there any specific challenges that the DOD may be facing that academic partnerships could help them overcome?

Current major challenges with hypersonic flows are investigation and control of related phenomena, such as viscous heating, wave drag, heat transfer and thermal transport, thermal acoustic heat transfer, control of shock wave unsteadiness, and wave induce heat flux.



Understanding these phenomena, and controlling associated physical effects, requires addressing basic, fundamental science and engineering areas. The process of understanding these very complex phenomena is ideally suited to university research, especially in regard to theoretical and numerical predictions, physical modelling, and innovative experimental testing, which could be facilitated through partnerships with key DoD laboratories.

Such partnerships are needed because associated experiments require elaborate facilities. Two of the most prominent and viable hypersonic flow facilities in the United States are at White Oak, Maryland, and in Tullahoma at Arnold Engineering Development Center. Several universities have hypersonic wind tunnels, but they're generally very small and somewhat limited in the range of flow conditions which can be produced. As such, new partnerships between DoD and university faculty, especially for experimental testing, will lead to new innovative solutions to the most complex physical phenomena, as they are associated with hypersonic weapons development.

How do you envision DOD and academic partnerships evolving over the next decade or so?

The DOD people that I know, especially at the Air Force Research Laboratory, the AFOSR, and at WPAFB, are very good and very experienced at interacting with academic people. But the problem is their budgets are somewhat limited, so they can only implement so many projects at any given time. Consequently, the most important improvement is larger research budgets. This would enable DoD funding entities to reach out to more academic institutions, interact with more academic people, and gain access to more academic leadership, which would benefit hypersonic weapons development greatly. In the future, I hope to see more partnerships and interactions between different universities and the DOD. As a result, I expect these partnerships to produce more innovative solutions to many of the complex technological problems associated with hypersonic weapons development.



That sounds very exciting. Last question, why are you excited to attend, as well as present, at the upcoming Hypersonic Summit?

Well first of all, I am looking forward to meeting a number of interesting and knowledgeable people, who have broad and in-depth understandings of hypersonic weapons development issues. As such, I know that I will learn much from the conference and from my interactions with such individuals. Of particular importance is new understanding and a broader perspective, as well as the current DOD perspective on relevant hypersonic research and application problems and issues, including current technological concerns, and considered approaches to address related issues. Such information will be invaluable for me, as well as for everyone who will be attending the conference.



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