UNIVERSITY OF MINNESOTA
Driven to Discover℠

Postdoctoral researcher position

High-dimensional design of experiments for relevant hypersonic flight conditions

The **Stochastic Hypersonics** group in the Department of Aerospace Engineering and Mechanics (AEM) at the University of Minnesota Twin Cities has a fully funded postdoctoral researcher position for up to two years starting in Fall 2024 (no earlier than Sept 1st 2024).

Qualifications

- A Ph.D. in Aerospace Engineering, Mechanical Engineering, Applied Mathematics or Computer Science by the time the appointment starts.
- Prior experience with stochastic methods and uncertainty quantification techniques.
- Proved skills in scientific computing (C++, Fortran and/or Python).
- Good understanding of basic computational fluid dynamics.
- Ability to work in a multidisciplinary, international research team and have strong verbal and written communication skills.
- Interest in mentoring graduate and undergraduate students.

How to apply

To apply for this position, please submit a motivation letter, CV, and names/contact information for two or three references to Dr. Anabel del Val at adelvalb@umn.edu. Please include "Postdoc position - Stochastic Hypersonics" in the subject line of the email. Full consideration will be given to complete applications received until the position is filled.

Context and motivation for the proposed research

Modeling uncertainty is a missing gap in hypersonics. Only a handful of all the produced research include uncertainty as a modeled component. New, surprising insights are being gained by trying to attain some objectivity in model calibration and validation tasks. **Calibration and validation of physico-chemical models require of specifically designed experimental data** which are rarely considered in themselves. Generally, legacy experimental data or new experimental campaigns targetting a broad spectrum of conditions (generally for more than one purpose) are used for model determination and validation. This approach is problematic as many of the experiments carried out don't bring any useful information to our models. Furthermore, **experimental design is considered only through the lens of a few parameters** that are thought to impact the most the outcomes of the measurements and relevant testing environments. **This common approach severely impacts how resources are distributed when planning an experimental campaign, and how much information we can retrieve from such experiments**. With the advent of high-dimensional stochastic modeling of recent years, **we are in a position to break in new ground and challenge the paradigm by which we design our experiments**. This would lead to a better understanding of the physics in high-speed flows and better utilization of resources to substantially improve the confidence we have in our in-flight predictions.

Objectives

In the present work, we wish to **build a general framework for systematically designing ground experiments** (choice of testing condition parameters and observations) that carry the most information about the model parameters that impact the most our chosen quantity of interest in the in-flight scenario. Two important flowfields and experimental facilities will be considered: post-shock regions behind a normal shock in shock tube experiments, and boundary layers in plasma wind tunnel tests. We will look at the highly-dimensional space that comprises all that it is not precisely known about our flowfields and study the sensitivity of selected observations to such unknowns under a wide range of testing conditions. The selected candidate will have the opportunity to develop novel algorithms that look for certain sensitivities in our complex models brought by the different testing conditions. On a second step, Bayesian inference analyses with adaptive model discrepancy will be carried out to verify the potential of the experimental design with synthetic experimental data and study the implications of having different sources of model error in the in-flight scenario.

Why the Stochastic Hypersonics group

The Stochastic Hypersonics group led by Dr. Anabel del Val successfully blends stochastic methods within hypersonic flow research to advance the state-of-the-art models, simulations and experiments. Our research is truly interdisciplinary at the interface of applied mathematics and engineering. As a young research group, the successful candidate will have the opportunity to learn first-hand what it entails to build a new research program as well as contribute directly with new ideas. The group is also actively collaborating with international partners in Europe and the US which brings additional opportunities for networking and international travel.