High-Speed Flow and its Control Through Plasma Technology

Tuesday, April 29, 2014, 3:30P.M.

Lower Level Auditorium, Geddes Hall

Refreshments served at 3:00 p.m. in the Geddes Hall Coffee House

To support the design of high-speed air vehicles, a number of scientific challenges must be addressed in the prediction and control of supersonic and hypersonic flow. The present talk focuses on two main themes: large-scale unsteadiness and plasma-based flow control.

Large-scale separation unsteadiness is a crucial issue in high-speed aircraft design because it promotes structural fatigue loading. To investigate the phenomenon, spectra of wall pressure fluctuations were compared for data obtained from wind tunnel experiments, the HIFiRE-1 flight test, and large-eddy simulations. The results were found to be in generally good agreement, despite differences in Mach number and two orders of magnitude difference in Reynolds number. Relatively good agreement was also obtained between these spectra and the predictions of a theory developed by Plotkin. The results support the idea that separation unsteadiness has common features across a broad range of compressible flows, and that the separation region behaves as a selective amplifier of large-scale disturbances in the incoming flow.

The idea of plasma-based flow control can trace its origin to the beginning of the space age, in particular to a time when designers realized that plasmas would have a significant influence on reentry flows. Interest in the field has grown significantly in recent years, and a number of plasma-based flow control concepts will be discussed in the presentation: mitigation of large-scale separation unsteadiness using plasma actuators, modeling of nanosecond-pulse dielectric barrier discharges, and the magnetohydrodynamic reentry heat shield. Simulations carried out by the author have established the feasibility of plasma control in the high-speed regime, and the field has reached a stage where we can consider practical implementations on air vehicles.

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If you are interested in meeting individually with Dr. Poggie, please contact Linda at 631-5431.