Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Comparison of CFD and Theoretical Post-Shock Gradients in Hypersonic Flow[1] GRAHAM CANDLER, University of Minnesota — In recent work of Hornung, expressions for the gradients of flow properties immediately behind a curved shock wave were obtained for a reacting gas. In this work, I use the expressions derived by Hornung to compare with inviscid computational fluid dynamics simulations of a Mach 8 flow over a cylinder. A finite-rate vibrational relaxation model is used to simplify the comparisons with theory. The shape of the bow shock wave is extracted from the CFD results, fitted with a polynomial, and then used to compute the post-shock gradients of the main flow variables. It is found that in general the CFD results are in very good agreement with the theory for both perfect gas and vibrationally relaxing flows. There are some notable differences, mostly centered on the location of the change in sign of the post-shock density gradient; this quantity is found to be very sensitive to the relaxation rate of the gas. The theoretical post-shock gradients provide a rigorous test of CFD and suggest possible experiments that would be very sensitive test of the models of finite-rate vibrational and chemical processes.

[1]This work was sponsored by the Air Force Office of Scientific Research under grant FA9550-04-1-0341 and by the Department of Defense National Security Science and Engineering Faculty Fellowship.

Graham Candler
University of Minnesota

Date submitted: 08 Aug 2009 Electronic form version 1.4