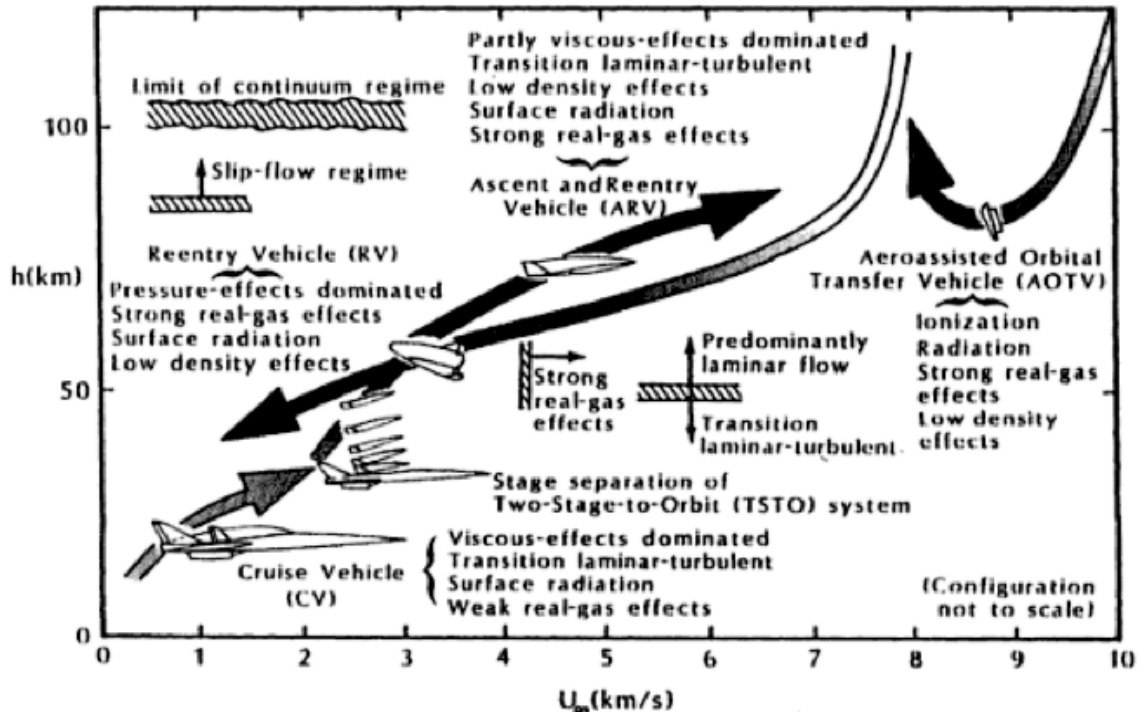


## AAE 690: NONEQUILIBRIUM REAL-GAS DYNAMICS Spring 2012



Four major classes of hypersonic space-transport vehicles and major aerothermodynamic effects. Fig. 1.2 from J. J. Bertin, "Hypersonic Aerothermodynamics"

This course is aimed at providing an introduction to kinetic theory of reactive molecular gases. Additional emphasis is given on practical significance of nonequilibrium phenomena in high-speed gas flows. The format of the class will be seminar-type presentations and discussion of key topics in nonequilibrium gas dynamics.

**Day & Time:** 11:30 am – 1 pm

**Room:** ARMS 1021

### References:

- 1) W.G. Vincenti, C.H. Kruger, *Introduction to Physical Gas Dynamics*. Krieger, 1965 [Reprint 2002]
- 2) C. Park, *Hypersonic Aerothermodynamics*.
- 3) Chapman, Cowling, *The Mathematical Theory of Non-uniform Gases*.
- 4) E. Nagnibeda, E. Kustova, *Non-Equilibrium Reacting Gas Flows*.
- 5) Current conference and journal publications

**Grading:** will be based on up to 3 in-class presentations on specific topics in non-equilibrium gas dynamics, possibly related to students' thesis research.

## **Outline**

- I. Governing Equations of Real-Gas Dynamics.
  - a) Navier-Stokes with multi-temperature models.
  - b) Master kinetic equation.
  - c) Boltzmann equation for reacting gases with internal degrees of freedom.
  - d) Chapman-Enskog approximation
- II. Rotational and Vibrational Energy Excitation and Transfer for Diatomic and Polyatomic Molecules
- III. Electronic Excitation
- IV. Chemical Reactions in High-Enthalpy Air
- V. Collision-Radiative Processes
- VI. Nonequilibrium Ablation Processes