Workshop on Kinetic Models and Methods for Rarefied Gas Dynamics
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The super / hypersonic low density wind tunnels of Icare: an experimental tool for rarefied gas dynamics research

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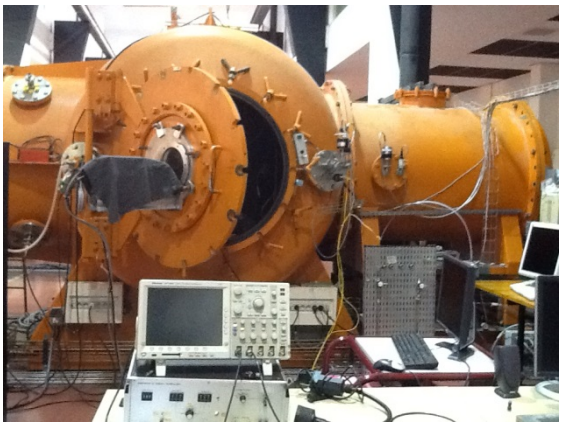
At very high altitudes, for high speed flights, the atmosphere becomes so rarefied that it no longer behaves like a continuous medium. As a consequence the molecular character of the flow changes its thermal and aerodynamic properties and the theoretical approach developed for continuous gas medium is no longer valid. The starting point of the rarefied gas theory is the kinetic Boltzmann equation, and a particular attention has to be payed to the description of the gas-surface interaction which serves as a boundary condition for the kinetic equation. Depending in the flight altitude, the flow rarefaction leads to different rarefaction degrees of interaction between the space vehicle surface and the external flow. Models and theoretical predictions have to be validated with experimental results representative for real case conditions. For this purpose, super/hypersonic rarefied facilities are used to simulate such atmospheric flight conditions.



The Icare laboratory, from the CNRS Institution based at Orleans, has an experimental platform named 'FAST' with three facilities dedicated for the investigation of aerothermodynamics of high speed/high enthalpy flows at low density. The facility Marhy (ex SR3 at the Laboratoire d'Aérothermique) offers the possibility to investigate the aerodynamics of sounding probes at rarefied conditions representative of the mesopause region described by the transition regime. However, the working capabilities of Marhy covers a wide range of Mach numbers ranging from subsonic to hypersonic regime (M=0.6-21) and Reynolds numbers ranging from 3.7 10^2 to 6.68 10^4 assuming a model length of 10 cm.

The purpose of this presentation focuses on the careful analysis which is needed to determine the compatibility of the wind tunnel experiments and atmospheric flight conditions. The operating mode of the wind tunnel will be detailed in order to specify the importance on the reproducibility on measurements results. Another point that will be discussed concerns eexperimental devices that are used to describe the flow field such: pressure transducers, aerodynamic balance, heat transfer gages and infrared thermography. When using such diagnostic tools in rarefied flow, a particular care is required such orifice effects from Pitot probes measurements or thin-skin method for heat flux measurements.

These considerations will be illustrated by experimental studies carried out in the Marhy facility.