INVESTIGATION OF DYNAMIC STABILITY IN TRANSONIC AND SUPERSONIC REGIME

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Entry capsules provide an attractive option for planetary exploration missions. Designed to survive during early phases of atmospheric entry, these vehicles often become dynamically unstable at low altitudes. Proper characterization of aerodynamic damping can allow drogue chute deployment at lower Mach number. Such findings may permit smaller drogue chute designs, thus enabling a payload volume and weight increase as well as a vast decrease in drag penalties.

Dynamic stability investigation deals with the characterization of a damping in pitch parameter. In order to determine the behaviour of a space vehicle in flight, two experimental techniques, namely the free oscillations and the forced oscillations experiments, are performed at VKI for this project.

The first one involves the measurement of the angle of attack in function of time while the model is freely oscillating, whereas the second one is about the evaluation of the pitching moment when a driving system produces the model oscillations.

To be able to use the data obtained for the flight configuration, similarity parameters have to be matched: the geometry, the Mach number and the reduced frequency of the oscillations are currently used for this purpose. The stability issues are involved in general during the late phase of the atmospheric re-entry and concerns the low supersonic regime as well as the transonic one: the tests are made at Mach numbers equal to 0.5, 0.7, 0.9 and 2.0.

A characterization of the damping in pitch parameter is obtained for the three models tested, namely Apollo, Pares and Expert, allowing knowing the oscillation damping behaviour of the real vehicles for a range of flow conditions, represented by the couple {Mach number/Altitude of flight}.

Figure 1: Models

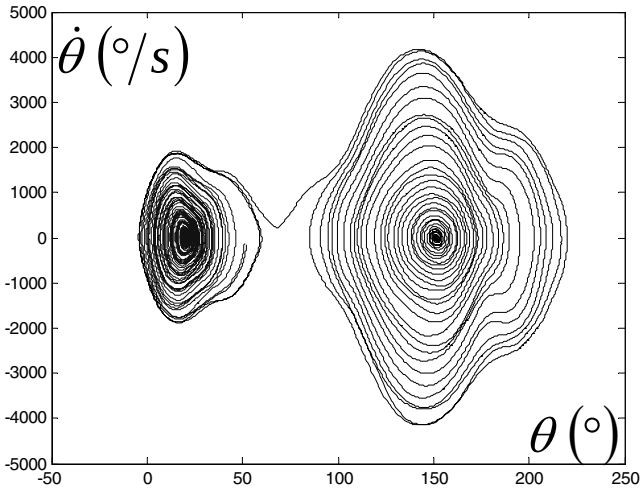

Figure 2: Phase diagram