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Corrected Waverider Design for Inlet Applications

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The operation of an airbreathing hypersonic engine is closely coupled to the vehicle design. Using the waverider concept, an efficient forebody can be designed to deliver the desired flow properties to an airbreathing engine. In this work, a modified design method for a so-called "osculating cones" waverider is presented. The original osculating cones solution builds a three-dimensional flowfield from slices of locally-conical flow. Previous osculating cone waverider solutions have not taken into account azimuthal pressure gradients that result from gradients in shock curvature. This present work takes these gradients into account, and includes an azimuthal pressure correction to more accurately match desired flowfield properties at an engine inlet. The flowfield is designed for limited non-uniformities in pressure, temperature, and density, and assumes axial flow. These azimuthal velocities are found to be very small compared to the streamwise directions. The azimuthal component is also found to be inboard; thus flow is not spilled. Their inclusion makes the osculating cone method more of an exact solution.

Nomenclature

C_D	=	drag coefficient
C_L	=	lift coefficient
H	=	height of the shockwave at centerline, m
L/D	=	lift-to-drag ratio
L	=	length of waverider, m
M	=	freestream Mach number
P	=	pressure, Pa
R	=	radius of curvature, m
T	=	temperature, K
V	=	velocity, m/s
Z	=	flight altitude, km
x,y,z	=	Cartesian coordinates
u,v,w	=	velocity cartesian coordinates
r, θ	=	conical coordinates system
β	=	shock wave angle
ρ	=	density, kg/m^3

I. Introduction

HYPERSONIC cruisers and reentry vehicles will benefit from high lift-over-drag (L/D) ratio; accelerators such as access-to-space airbreathers also benefit from high L/D when it is achieved with minimal drag and lift matched to weight. For an airbreathing engine, the flow entering the inlet should most likely present the most highly uniform flow possible with high efficiency. Those properties are determined in large measure by the choice of the forebody of the vehicle.

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