Abstract

This research was undertaken to attempt to resolve a discrepancy between observations and theoretical predictions in shock wave reflections. Known as the von Neuman Paradox in this context, it is the failure of theory to predict when reflection geometry of a shock wave reflecting off a wedge inclined to its path will take the form of regular or Mach reflection, reflection geometries that are characterised by two and three shock waves respectively. The theory predicts transition at a lower Mach number than has been repeatedly observed, for a given wedge angle. It has been postulated that the cause of the discrepancy is due to thermal and viscous transport phenomena on the surface of the reflecting wedge. The proposed mechanism is that the thermal and viscous interaction of the shock wave with the surface creates a boundary layer that relaxes the assumptions of the theory. This postulation has been borne out by numerical investigation and an experimental investigation that is free from boundary layer effects at a single wedge angle. That investigation, like the two angles investigated in this research, reflected a pair of equal strength shock waves symmetrically off each other in a manner that is representative of shock wave reflection off a wedge. The inferred wedge, formed by the plane of symmetry of the shock reflection, is free from the boundary layer effects that are postulated to be the cause of the discrepancy. The research presented here found that the two angles investigated did not suffer from a persistence of regular reflection within experimental accuracy. For the 20° wedge a transition Mach number of 1.022 was found when the transition value calculated from the detachment criterion was nearest at Mach 1.018. The experiment representative of a 48° wedge indicated transition at Mach 1.372 which is almost identical to the sonic criterion's predicted value of Mach 1.376. These results broaden the range of the experimental validation that surface transport phenomena are the cause of the persistence of regular reflection, as the observations on an adiabatic, inviscid surface imply that there is no persistence.