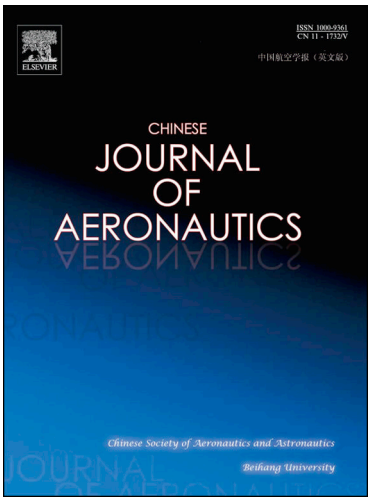

Effect of a transverse plasma jet on a shock wave induced by a ramp

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Effect of a transverse plasma jet on a shock wave induced by a ramp

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Abstract

We conducted experiments in a wind tunnel with Mach number 2 to explore the evolution of a transverse plasma jet and its modification effect on a shock wave induced by a ramp with an angle of 24°. The transverse plasma jet was created by arc discharge in a small cylindrical cavity with a 2 mm diameter orifice. Three group tests with different actuator arrangements in the spanwise or streamwise direction upstream from the ramp were respectively studied to compare their disturbances to the shock wave. As shown by a time-resolved schlieren system, an unsteady motion of the shock wave by actuation was found: the shock wave was significantly modified by the plasma jet with an upstream motion and a reduced angle. Compared to spanwise actuation, a more intensive impact was obtained with two or three streamwise actuators working together. From shock wave structures, the control effect of the plasma jet on the shock motion based on a thermal effect, a potential cause of shock modification, was discussed. Furthermore, we performed a numerical simulation by using the Improved Delayed Detached Eddy Simulation (IDDES) method to simulate the evolution of the transverse plasma jet plume produced by two streamwise actuators. The results show that flow structures are similar to those identified in schlieren images. Two streamwise vortices were recognized, which indicates that the higher jet plume is the result of the overlap of two streamwise jets.

Keywords: Plasma synthetic jet; Shock wave/boundary layer interaction; Time resolved schlieren system; Improved delayed detached eddy simulation(IDDES) method; Flow control

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