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Weak shock wave reflections due to transverse waves in a conventional shock tube

Cachucho, André Rodrigues

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Abstract

Previous experimental work, utilising a unique large scale shock tube, showed that the four-wave shock reflection pattern, known as the Guderley reflection existed for Mach numbers below 1.10 on wedge angles of 10° and 15°. The current study proves for the first time that these rare reflections can be produced in a conventional shock tube for Mach numbers ranging from 1.10 to 1.40 and for various disturbances in the flow. Two shock tube configurations were tested, the first consisted of a perturbation source on the floor of the tube, and the second utilised a variable diverging section (10°, 15°, and 20°). A new principle was applied where the developed Mach reflection undergoes successive reflections off the upper and lower walls of a tube to produce the desired reflection. The high resolution images captured using a sensitive schlieren system showed evidence of the fourth wave, namely the expansion fan, for the majority of the results for both shock tube configurations. A shocklet terminating the supersonic patch behind the reflected wave was interestingly only observed for Mach numbers of approximately 1.20. The wave structures were similar to those observed in previous experimental work, except no evidence of the second shocklet nor the multi-patch geometry was found. Multi-exposure images of the propagating shock superimposed on a single image frame, analysed with oblique shock equations, estimated the velocities near the triple point. It was shown that the reflected wave is very weak, and that the flow behind the Mach stem is supersonic confirming the shock reflections to be indeed Guderley reflections.