Weak shock reflection

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We present numerical solutions of a two-dimensional Riemann problem for the unsteady transonic small disturbance equations that provides an asymptotic description of the Mach reflection of weak shock waves. In self-similar coordinates, the solution satisfies a nonlinear mixed-type system of conservation laws with source terms. We develop a new numerical scheme to solve the self-similar equations, and use local grid refinement to resolve the solution in the reflection region. The solutions contain a remarkably complex structure: there is a sequence of triple points and tiny supersonic patches immediately behind the leading triple point that is formed by the reflection of weak shocks and expansion waves between the sonic line and the Mach shock. An expansion fan originates at each triple point, thus resolving the von Neumann paradox of weak shock reflection. The numerical solutions raise the question of whether there is an infinite sequence of triple points in an inviscid weak shock Mach reflection. It seems likely that the kind of behavior observed here also occurs in many other mixed-type systems of conservation laws.

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