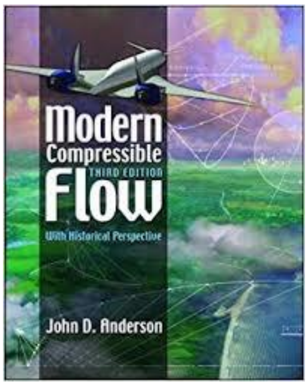
More complex shock calculations and interactions

There are a whole host of more complex shock interactions and calculations. For example, the basic shock calculations we have done assume a 2-dimentional structure – however they are modified if the structure has a 3-dimensional form (like a cone shape for example). Similarly, shocks can reflect of boundaries and each other, or interact and reinforce if they are heading in the same direction.

Many of these situations are discussed in chapter 4 of Anderson's book "Modern compressible flow" (the chapter titled "Oblique shock and expansion waves" in the 3rd edition):

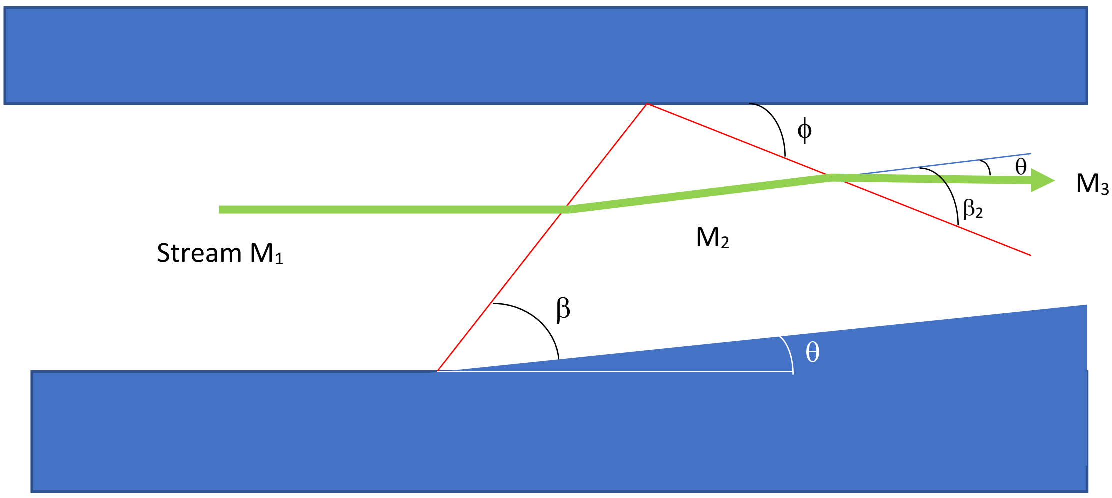
John D. Anderson, "Modern Compressible Flow: With historical perspective", MacGraw-Hill, 2004 (3rd ed).



Let's look at two common cases as an introduction.

1. Shockwave reflection from a solid wall

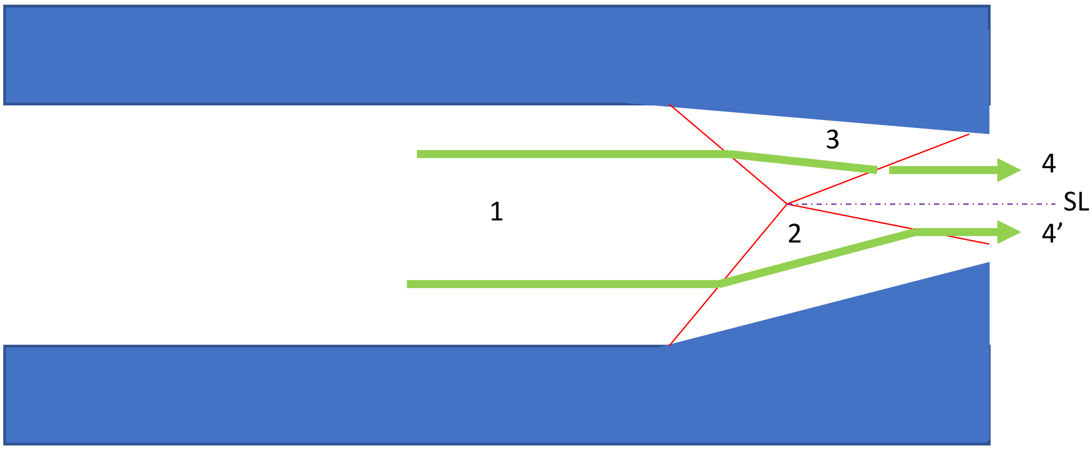
Shockwave do not reflect from walls like a light-beam (the angle of reflection is <u>not</u> equal to the angle of incidence). The situation is as shown in the diagram below.



You can see from the geometry of the situation that the input parameters necessary to calculate the characteristics after the second shock (M_3 etc) are input speed = M_2 and deflection angle θ (which is the same as the first deflection angle). This gives β_2 and hence all the other flow parameters. The angle between the wall and the second shock is $\phi = \beta_2 - \theta$.

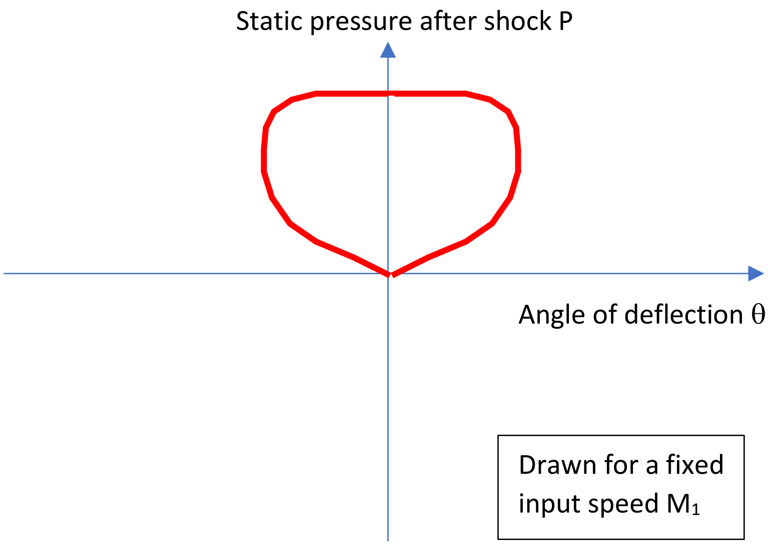
2. Reflection of one shock from another (in opposite directions)

This is the situation shown below.

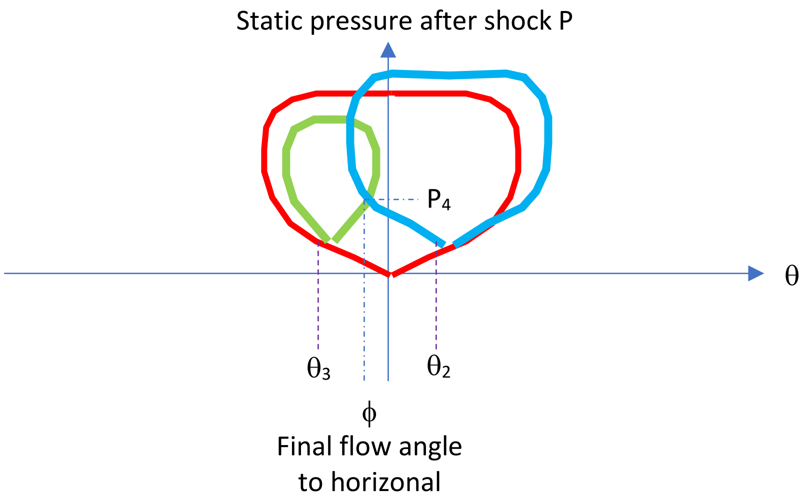


The two emergent streams meet at the slip-line (SL) at which they must have equal pressures (although the other parameters between regions 4 and 4' can vary). The angles of the resulting shocks can be worked out from simple geometry.

Such problems can be tackled by a number of means, but one easy one is to draw a *pressure-deflection diagram.* This is simply a diagram showing the static pressure after a shock (P) as a function of deflection angle θ. For a single shock, this looks as shown below.



Knowing the angles of deflections from geometry and using these to draw on the other shocks on the same scale, a diagram can be constructed to give the pressure along the slip-line and from this, the other parameters can be calculated.



Full details of the procedure can be found in Anderson's book.