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CORNER EFFECTS ON SHOCK-INDUCED SEPARATION

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It is almost impossible to imagine a supersonic, or even transonic, flow without shock waves and boundary layers interacting with each other. Therefore, shock wave/boundary layer interactions are one of the key building blocks of compressible flow. Two types of interaction are particularly common, the normal shock wave/turbulent boundary layer interaction (NSBLI) as seen on transonic wings or turbine and compressor blades, and the impinging oblique shock/boundary layer interaction (OSBLI) which is common in supersonic engine inlets. Both have been studied for many decades and they are often used as calibration test-cases for computational fluid dynamics (CFD). Because of their simple flow geometry these interactions are often considered to be two-dimensional. Many computations exploit this assumption and experimental investigations mainly concentrate on the 2D-nature of these flows, focussing on the central regions and ignoring sidewall effects.

More recently, however, there has been increasing evidence that this approach may not be justified. In reality, experiments are performed in wind tunnels where the flow field is typically bounded by sidewalls, forming stream-wise corners on either side of the interaction in question. Most research facilities are of limited size and therefore the assumption of high aspect ratio (approaching infinity) is invalid.

In this lecture I will discuss the effect of stream wise corners formed by the presence of sidewalls on a key aspect of SBLI - the existence and size of a separation region underneath the shock. This particular flow feature is of considerable interest because the presence of separation and CFD's ability to predict it has considerable impact in many applications, such as aircraft wings, jet engines and engine inlets. Recent research shows that far from being 2D, the width of a wind tunnel can strongly affect the onset, stream-wise extent and overall shape of shock-induced separation in both NSBLI and OSBLI. I will show examples for this behaviour and offer simple physical explanations for this effect in both flow fields. This new way of thinking about these basic flow fields allows us to better understand the variations observed in previous experiments and will also improve validation strategies for CFD leading to better predictions of three-dimensional compressible flows.