The SST sound cone cloud disc

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The cloud disc that slides along an SST aircraft's fuselage in acceleration across Mach I might be explained by the physics of an ultrasound field generated by the Doppler Effect.

Sound, mechanical and aerodynamic, generated by an aircraft accelerating towards Mach I, is confined within a sound cone, the apex of which is at a point at a decreasing distance in front of the nose. At Mach I, the aircraft nose is the cone's apex. Aircraft-generated sound energy in the sound cone travels at the speed of sound – laterally, perpendicular to the line of flight, and anteriorly where it builds up in intensity in front of the leading edges.

As air speed increases, the intensifying sound energy in the anterior sound cone is associated with rising sound frequency with the wavelength decreasing proportionately by the Doppler Effect. Reducing the aircraft to point size, the aerodynamic and aircraft mechanical sounds are confined within a perfect cone. At Mach I, the angle of the cone margins to the line of flight is 45 degrees (the sound radiating laterally from the line of flight the same distance as the plane moves forwards).

Cloud disc formation requires moisture content in the air in fine particulate or droplet form (ice-crystal mist or water mist, respectively). Doppler-induced ultrasound propels (sweeps) suspended matter forwards away from an ultrasound source (Lieberman, 1949,), which is the aircraft, creating a disc-shaped cloud, its rounded peripheral margins defined by the shape of the cross-section of the sound cone, within which it forms. At Mach I, the cloud disc touches the aircraft nose. As the aircraft accelerates beyond Mach I, the cloud disc slides along the fuselage (Figure 1), as the aircraft sound is left behind.

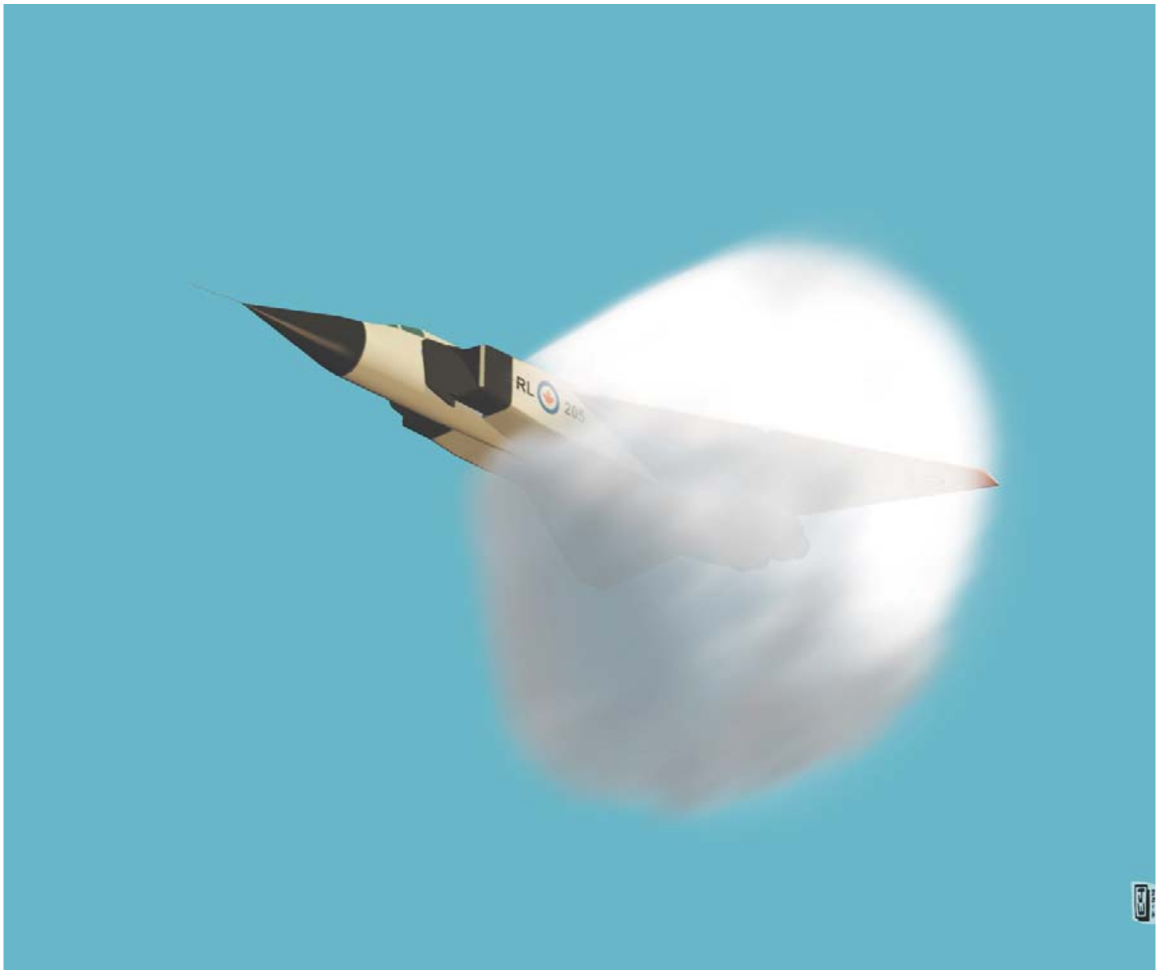

Figure 1: illustration of a cloud disc sliding along an Avro Arrow (circa 1959) accelerating through Mach I

Leading up to Mach I, high intensity molecular agitation, from the increasingly high energy and high frequency of ultrasound accumulating in the sound cone in front of the leading edges renders anterior sound cone air refractory to longitudinal flow of air in laminae. The air is converted to the consistency of a low-specific-gravity (gaseous) gel, the viscous nature of which resists penetration – and therefor is compressed by the leading edges. This creates a compression wave anterior to the aircraft nose and the leading edges of the wings.

The air-gel has its counterpart in the gel-like consistency that water exhibits as turbulent flow onsets in cylinders. An oscillation of a mass in a fluid creates a sound wave; the sounds created by the coherent boundary layer oscillations (which also may be termed “vibrations”) of transition are entrapped within a sound-reflective cylinder, and amplified by transverse echoing reverberation. This concentrates resonating transverse simple harmonic standing wave sound (wavelength = 2d, equating to very high frequency ultrasound for most laboratory cylinder flow studies) perpendicular to the laminae, “freezing” their longitudinal slip (laminar interlocking). As turbulent flow erupts, the cylinder's water column immediately becomes non-laminar and gel-like – transferring the flow resistance to the high resistance of the boundary. This accounts for the parabolic iso-velocity profile of laminar flow in cylinders abruptly becoming flattened as non-laminar turbulent flow appears (Hamilton 2015).

The high resistance of the anterior sound cone air is responsible for the "sound barrier" effect – a wall of jellied air – so obstructive to earlier, less aerodynamic aircraft as Mach I was approached. Sleek aerodynamic SST aircraft slip through the air-gel sound barrier as easily as a sharp knife slides through soft butter. As Mach I is exceeded, the "sound barrier" is breached as the leading edges enter undisturbed silent low resistance laminar air.

The explosive sound occurring when an aircraft "breaks the sound barrier," results from the pent-up high intensity, extremely high frequency and maximally short wavelength (molecular dimensions) ultrasound in the anterior sound cone exploding into the ultimate example of low frequency sound – one single vibration – releasing the stored energy in a very loud Doppler-related thunderclap.

Just as ultrasound energy is used for cooking, the high energy ultrasonic oscillation of air molecules in the anterior sound cone raises the temperature of the cloud disc, compared to the air outside the cone.

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