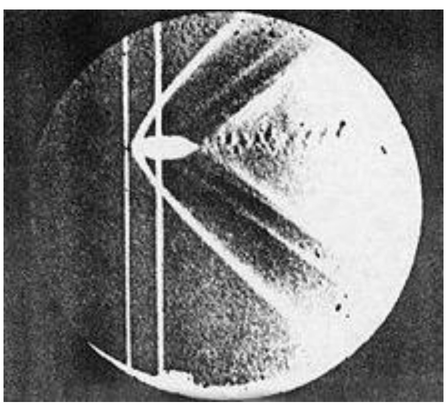
# TYPES OF SHOCK

## Detonation wave

Main article: Detonation

- A detonation wave is essentially a shock supported by a trailing exothermic reaction. It involves a wave traveling through a highly combustible or chemically unstable medium, such as an oxygen-methane mixture or a high explosive. The chemical reaction of the medium occurs following the shock wave, and the chemical energy of the reaction drives the wave forward.
- A detonation wave follows slightly different rules from an ordinary shock since it is driven by the chemical reaction occurring behind the shock wave front. In the simplest theory for detonations, an unsupported, self-propagating detonation wave proceeds at the Chapman-Jouguet velocity. A detonation will also cause a shock of type 1, above to propagate into the surrounding air due to the overpressure induced by the explosion.
- When a shockwave is created by high explosives such as TNT (which has a detonation velocity of 6,900 m/s), it will always travel at high, supersonic velocity from its point of origin.



Shadowgraph of the detached shock on a bullet in supersonic flight, published by Ernst Mach in 1887.

## Detached shock

- These shocks are curved, and form a small distance in front of the body. Directly in front of the body, they stand at 90 degrees to the oncoming flow, and then curve around the body. Detached shocks allow the same type of analytic calculations as for the attached shock, for the flow near the shock. They are a topic of continuing interest, because the rules governing the shock's distance ahead of the blunt body are complicated, and are a function of the body's shape. Additionally, the shock standoff distance varies drastically with the temperature for a non-ideal gas, causing large differences in the heat transfer to the thermal protection system of the vehicle. See the extended discussion on this topic at Atmospheric reentry. These follow the "strong-shock" solutions of the analytic equations, meaning that for some oblique shocks very close to the deflection angle limit, the downstream Mach number is subsonic. See also bow shock or oblique shock

- Such a shock occurs when the maximum deflection angle is exceeded. A detached shock is commonly seen on blunt bodies, but may also be seen on sharp bodies at low Mach numbers.
- Examples: Space return vehicles (Apollo, Space shuttle), bullets, the boundary (Bow shock) of a magnetosphere. The name "bow shock" comes from the example of a bow wave, the detached shock formed at the bow (front) of a ship or boat moving through water, whose slow surface wave speed is easily exceeded (see ocean surface wave).

## Attached shock

- These shocks appear as "attached" to the tip of a sharp body moving at supersonic speeds.
- Examples: Supersonic wedges and cones with small apex angles
- The attached shock wave is a classic structure in aerodynamics because, for a perfect gas and inviscid flow field, an analytic solution is available, such that the pressure ratio, temperature ratio, angle of the wedge and the downstream Mach number can all be calculated knowing the upstream Mach number and the shock angle. Smaller shock angles are associated with higher upstream Mach numbers, and the special case where the shock wave is at 90 degrees to the oncoming flow (Normal shock), is associated with a Mach number of one. These follow the "weak-shock" solutions of the analytic equations.

## Recompression shock

- These shocks appear when the flow over a transonic body is decelerated to subsonic speeds.
- Examples: Transonic wings, turbines

- Where the flow over the suction side of a transonic wing is accelerated to a supersonic speed, the resulting re-compression can be by either Prandtl-Meyer compression or by the formation of a normal shock. This shock is of particular interest to makers of transonic devices because it can cause separation of the boundary layer at the point where it touches the transonic profile. This can then lead to full separation and stall on the profile, higher drag, or shock-buffet, a condition where the separation and the shock interact in a resonance condition, causing resonating loads on the underlying structure.

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