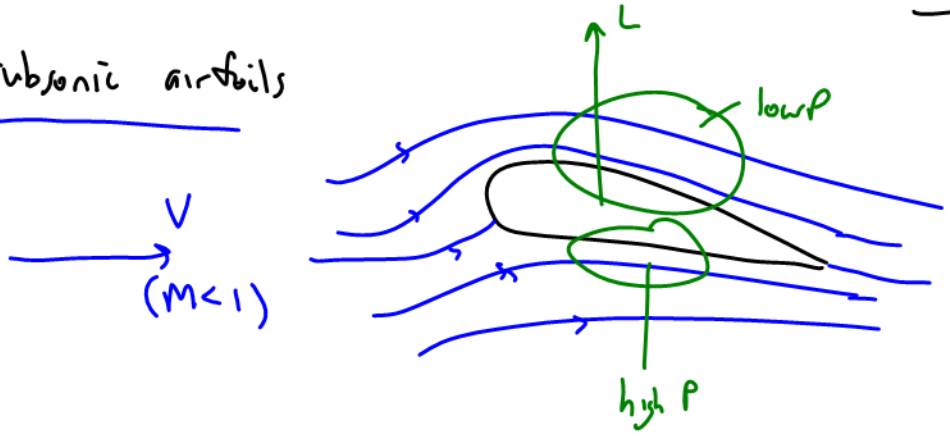
This is the last lecture! ☺ **Today, we will**:

- Discuss supersonic airfoils – an application of oblique shocks and expansion fans
- If time, review for Final Exam
- Do Candy Questions for Candy Friday

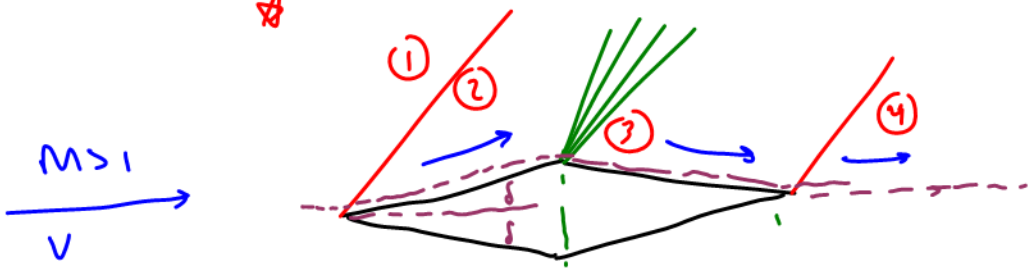
APPLICATION OF OBLIQUE SHOCKS & EXPANSION FANS → SUPERSONIC AIRCRAFT WINGS

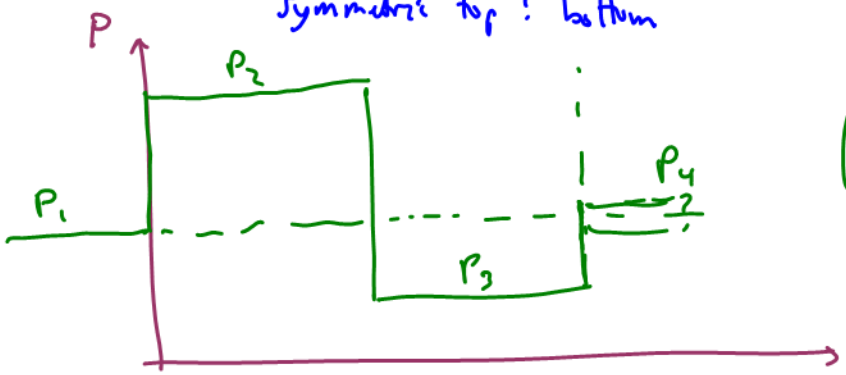
- Recall, subsonic airfoils



- Supersonic airfoils
  - THINNER
  - sharp leading edge

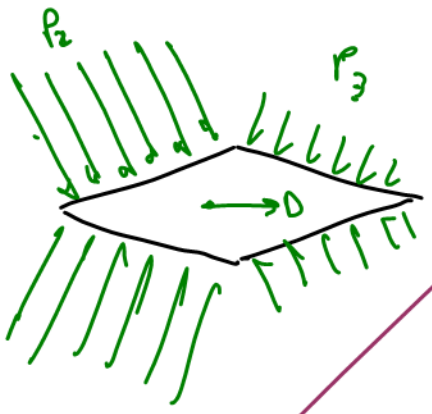
E.g., a DIAMOND AIRFOIL @ zero AoA angle of attack (α)





LIFT = 0 since symmetric

DRAG?



DRAG ≠ 0

(in real life, also have skin friction drag)

Called WAVE DRAG ☆

Compare:

- 2-D incompressible inviscid flow

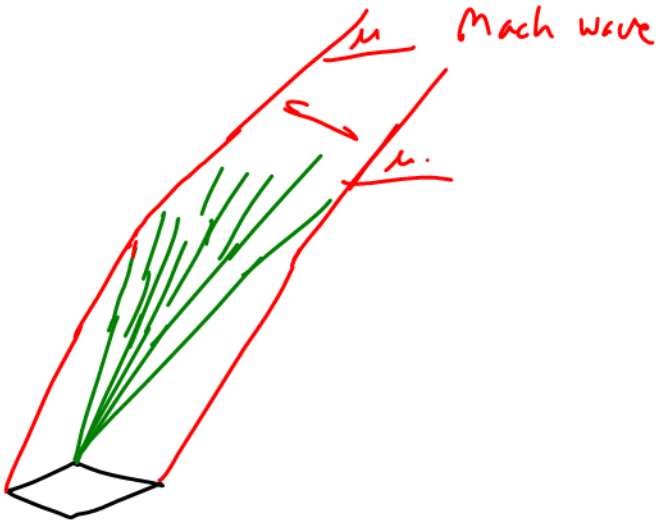
Drag = 0 even if lift ≠ 0

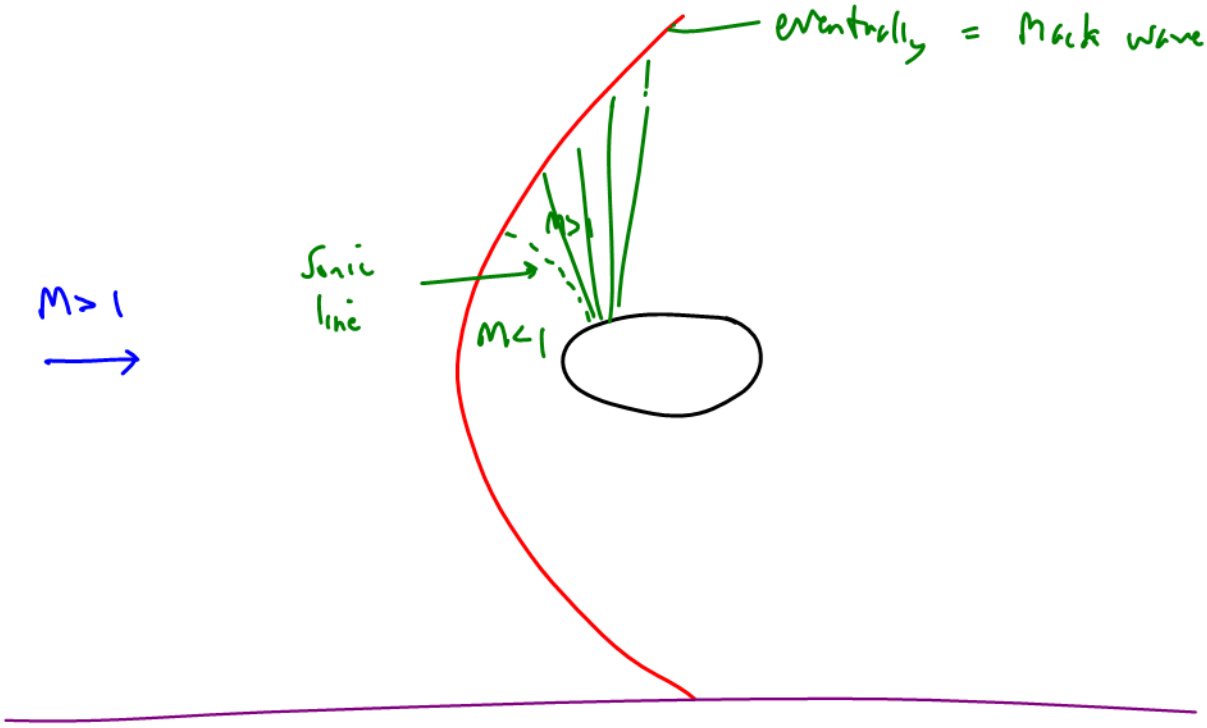
D'Alembert's paradox

- 2-D supersonic inviscid flow

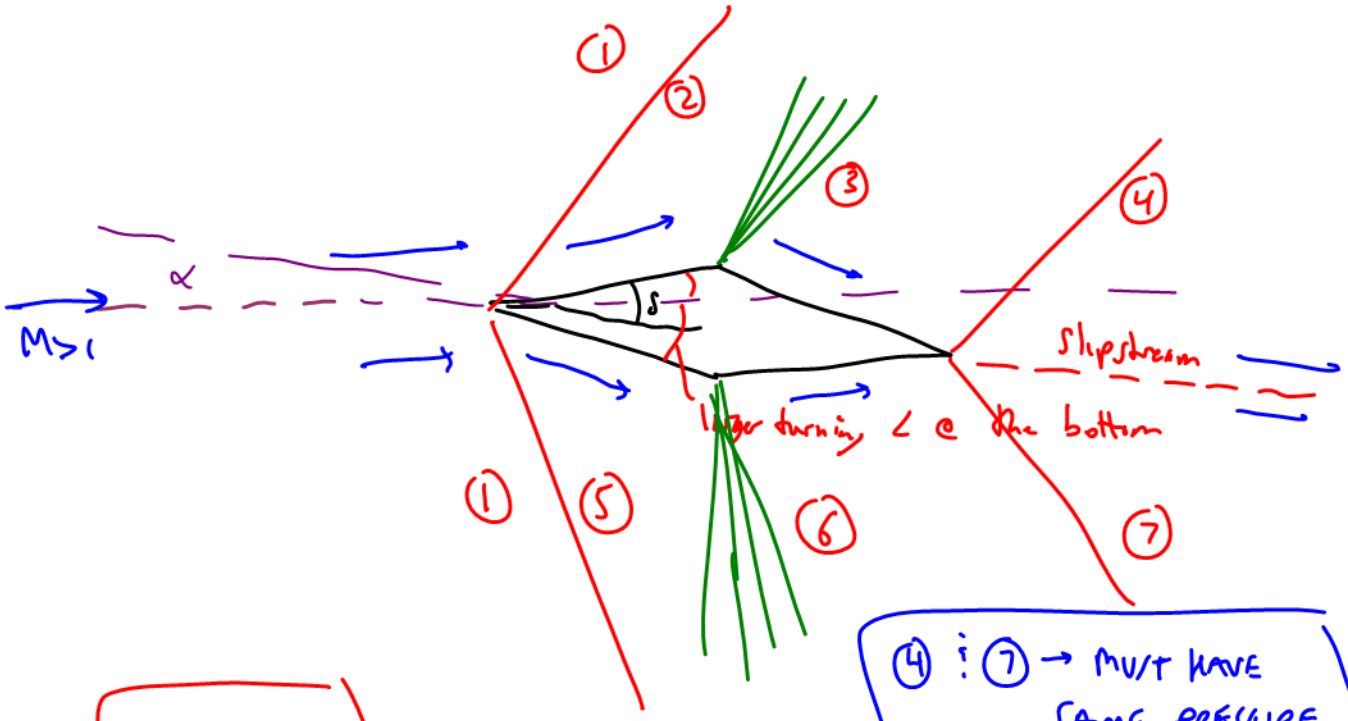
Drag ≠ 0 even if lift = 0 !

From "far away"





DIAMOND AIRFOIL @ $\alpha > 0$ BUT $\alpha < \delta$



SLIPSTREAM

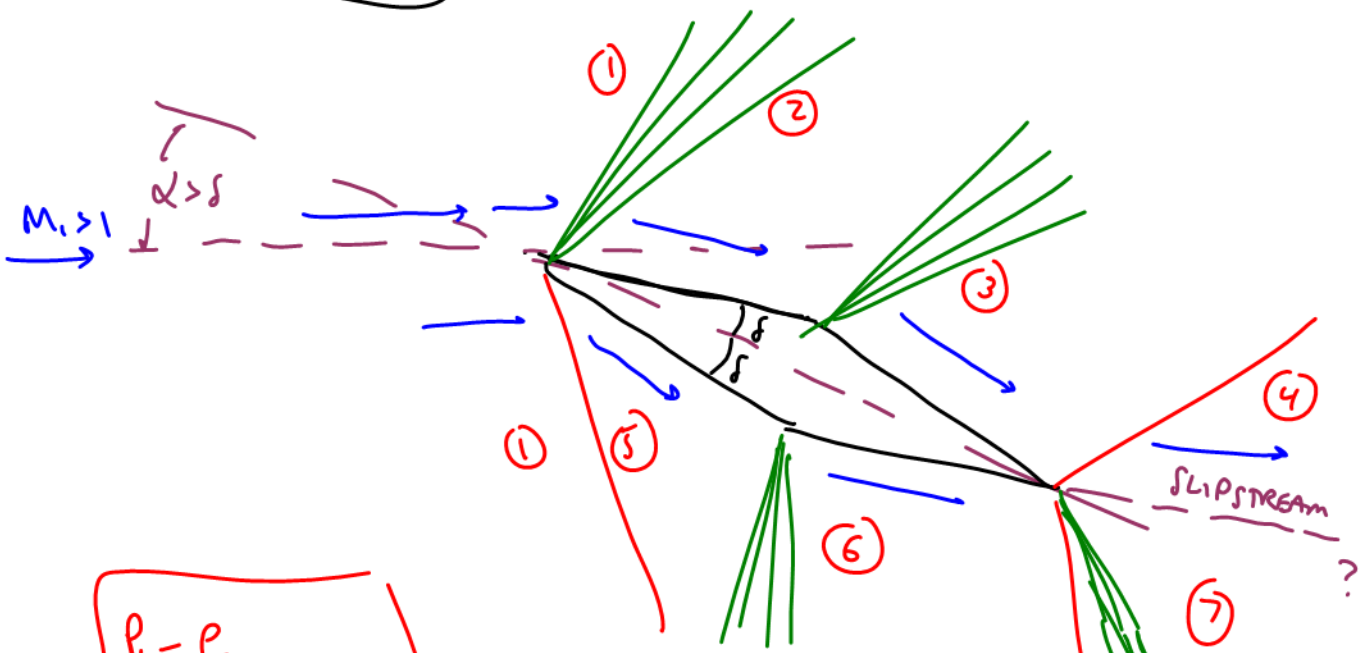
④ : ⑦ → MUST HAVE SAME PRESSURE

But $M_4, V_4, T_4, \ldots$ can differ from $M_7, V_7, T_7 \ldots$

Since ∠ @ bottom > ∠ @ top ①→②

①⑤ — $P_5 > P_2$; $P_1 > P_3$ ⇒ LIFT !

LOOK AT $\alpha > \delta$ case

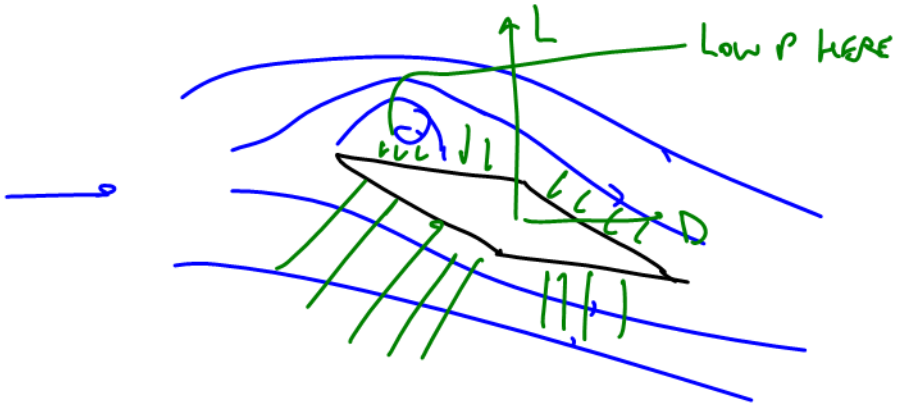


$P_4 = P_7$
across slipstream

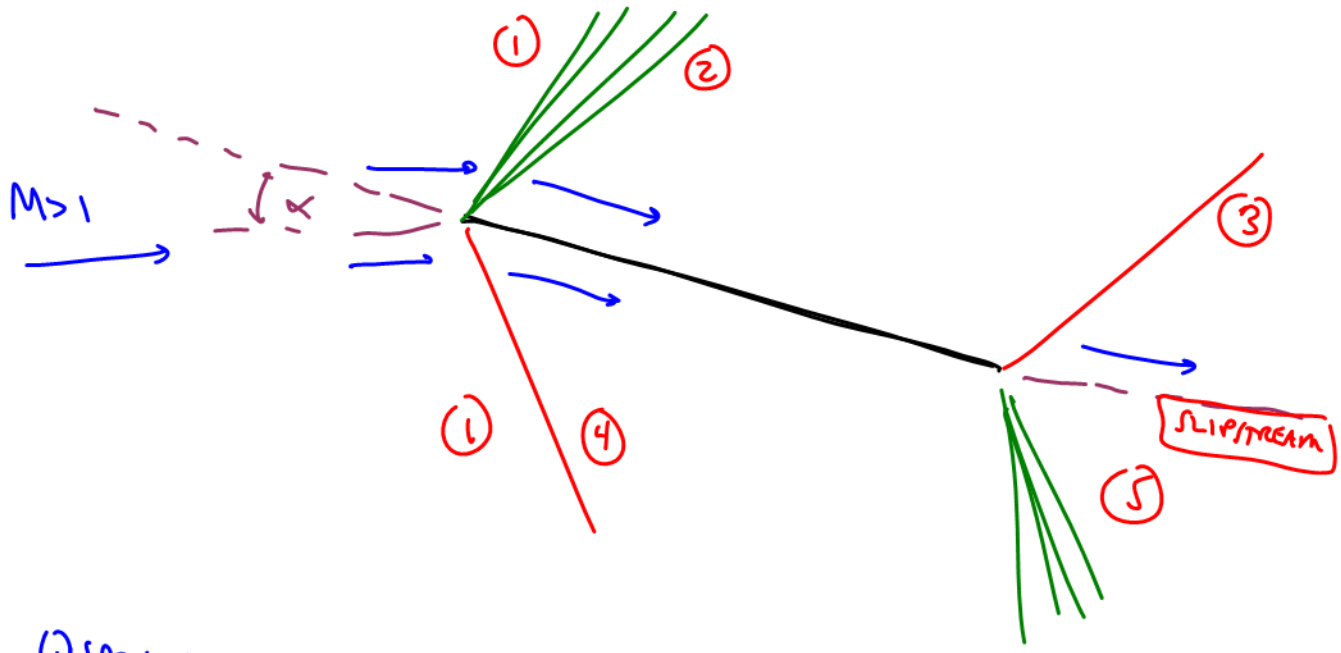
either oblique shock
or exp. fan

$P_5 >> P_2$ $P_6 >> P_3$ ∴ LOTS OF LIFT + LOTS OF DRAG

SUBSONIC FLOW ? eg. take off



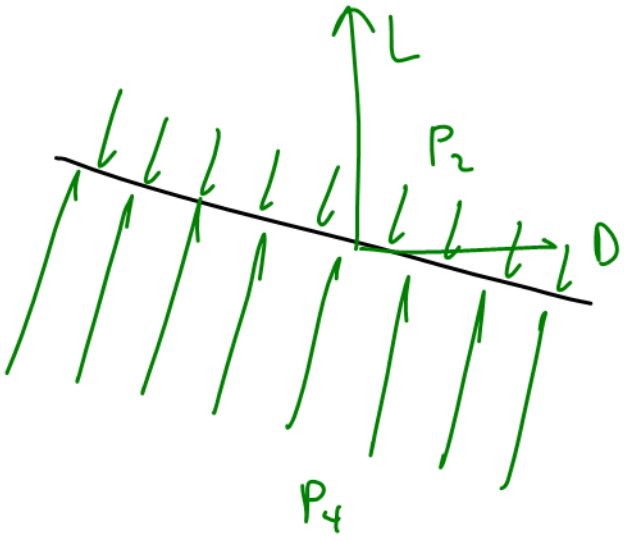
SIMPLEST CASE → FLAT PLATE @ $\alpha > 0$

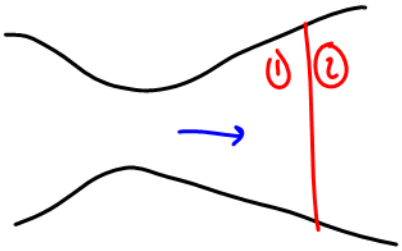


QUALITATIVE

$P_2 < P_1$ through exp. fan

$P_4 > P_1$ through oblique shock





$P_2 > P_1$ (Q) is $P_2^* < = > P_1^*$?

Hint: $P_{0_2} < P_{0_1}$ $\frac{P^*}{P_0} = 0.5283$ for air

$P_1^* = 0.5283\, P_{0_1}$ $P_2^* = 0.5283\, P_{0_2}$