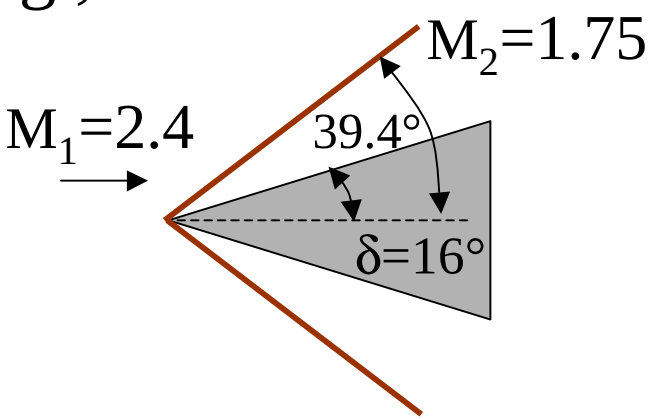
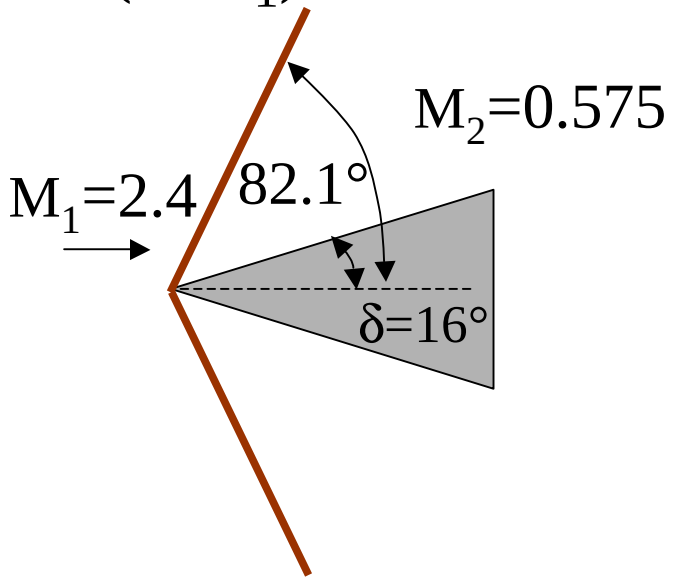
Strong and Weak Oblique Shocks

- As we have seen, it is possible to get two solutions to equation (VI.46)

$$\tan\delta = \left[\left(2/\tan\theta\right)\left(M_1^2\sin^2\theta - 1\right)\right] \Big/ \left[M_1^2\left(\gamma + \cos 2\theta\right) + 2\right]$$

  - 2 possible values of θ for given (δ, M_1)
  - e.g.,

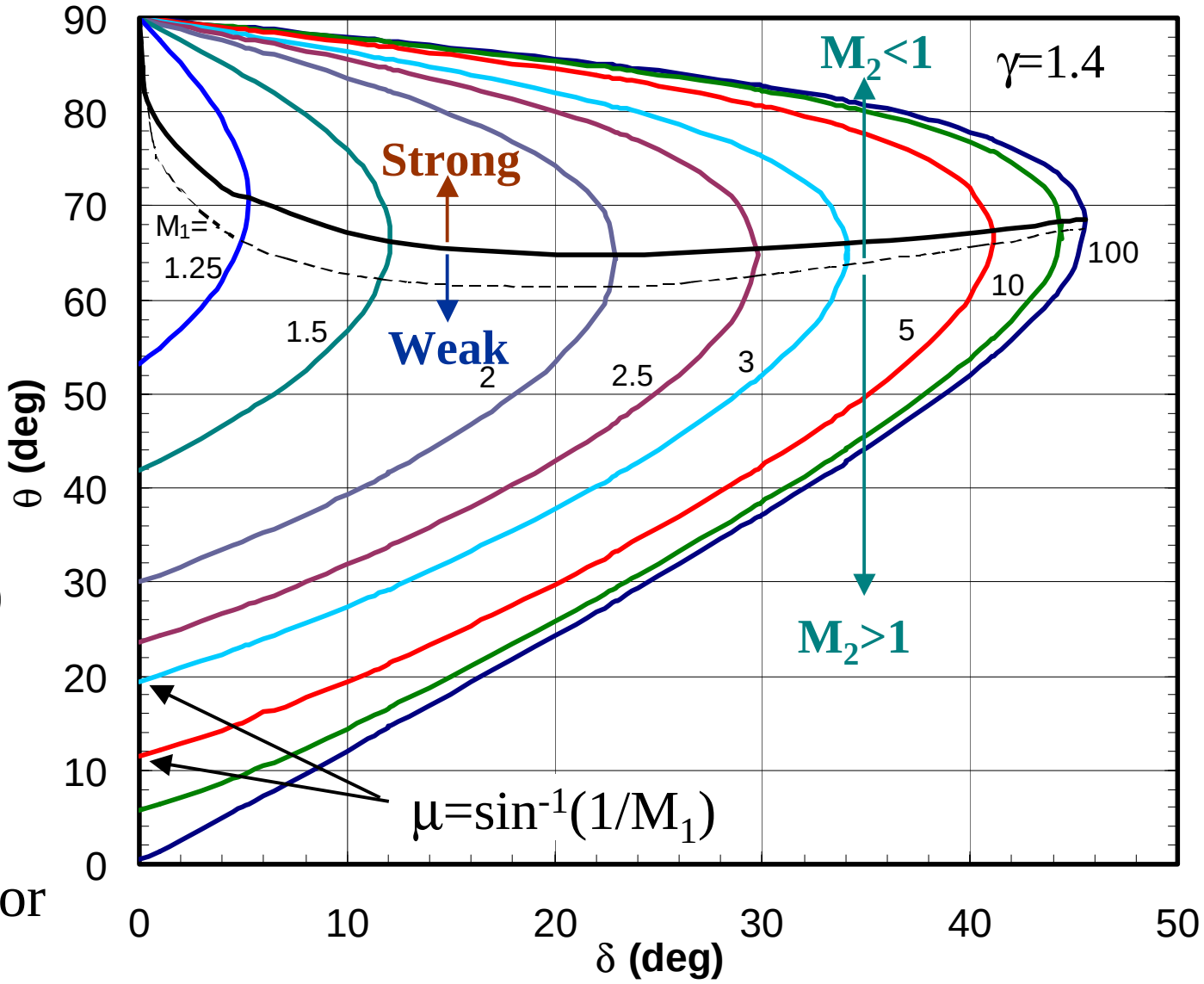




- Examine graphical solution

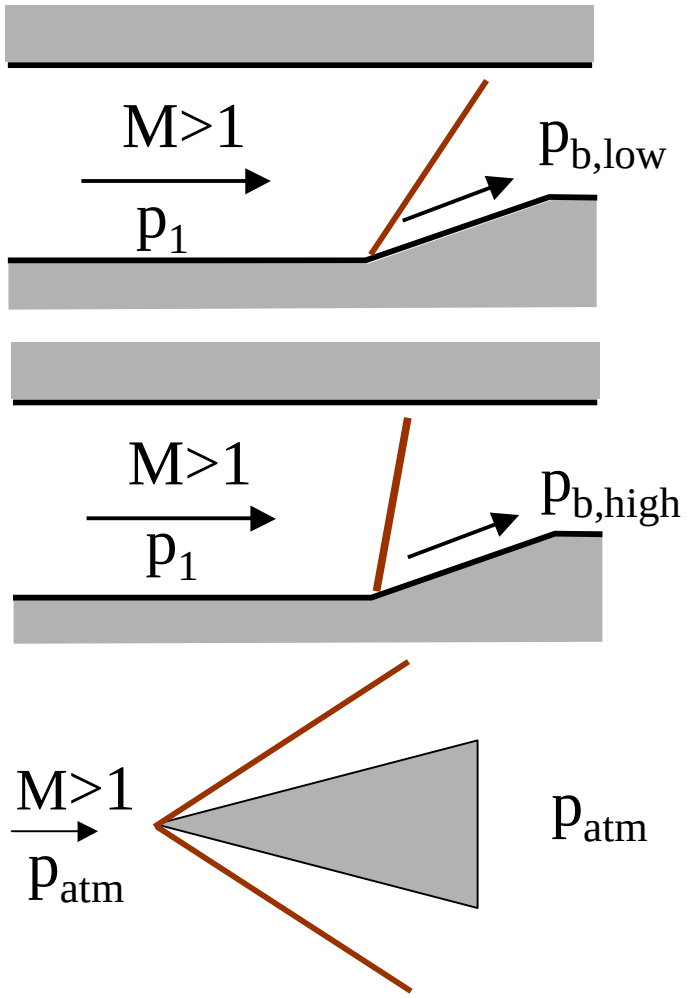
Graphical Solution

- **Weak shocks**
  - smaller θ
  - $\theta_{min}=\mu$
  - usually $M_2>1$
- **Strong shocks**
  - $\theta_{max}=90°$ (normal shock)
  - always $M_2<1$
- Both for δ=0
  - no turn for normal shock or Mach wave



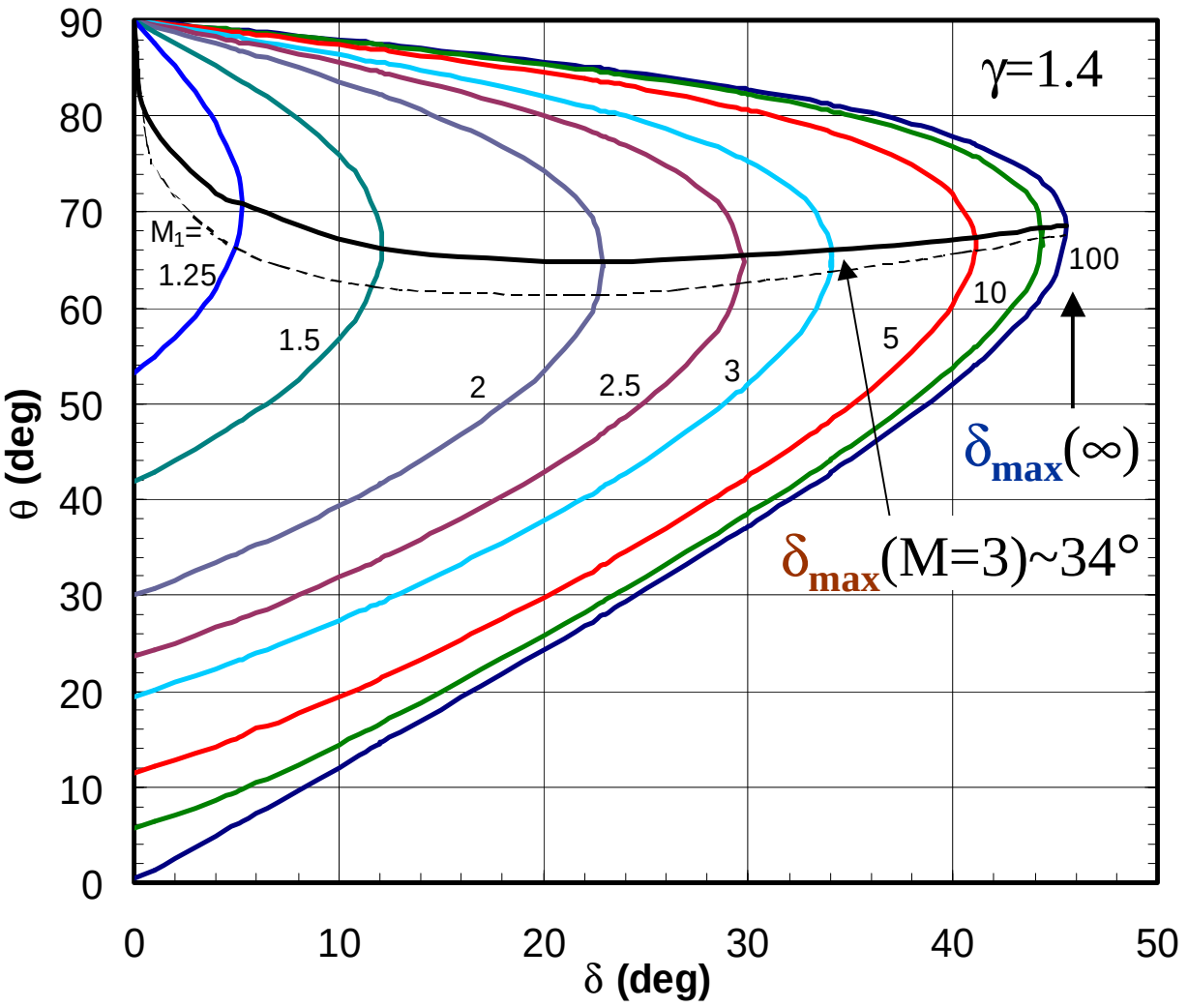
Which Solution Will Occur?

- Depends on upstream versus downstream pressure
  - e.g., back pressure
  - p_2/p_1 large for strong shock
    small for weak shock
- Internal Flow
  - can have p_2 much higher or close to p_1
- External Flow
  - downstream pressure usually close to upstream p (both near p_{atm})



Maximum Turning Angle

- Given M_1, no straight oblique shock solution for $\delta > \delta_{max}(M)$
- Given δ, no solution for $M_1 < M_{1,min}$
- Given fluid (γ), no solution for any M_1 beyond δ_{max} e.g., ~45.5° (γ=1.4)



Detached Shock

- What does flow look like when no straight oblique shock solution exists?
  - **detached shock/bow shock,** sits ahead of body/turn
  - normal shock at centerline (flow subsonic to negotiate turn); curves away to weaker shock