Quasi-1D Steady Flow

Lecture 23

ME EN 412
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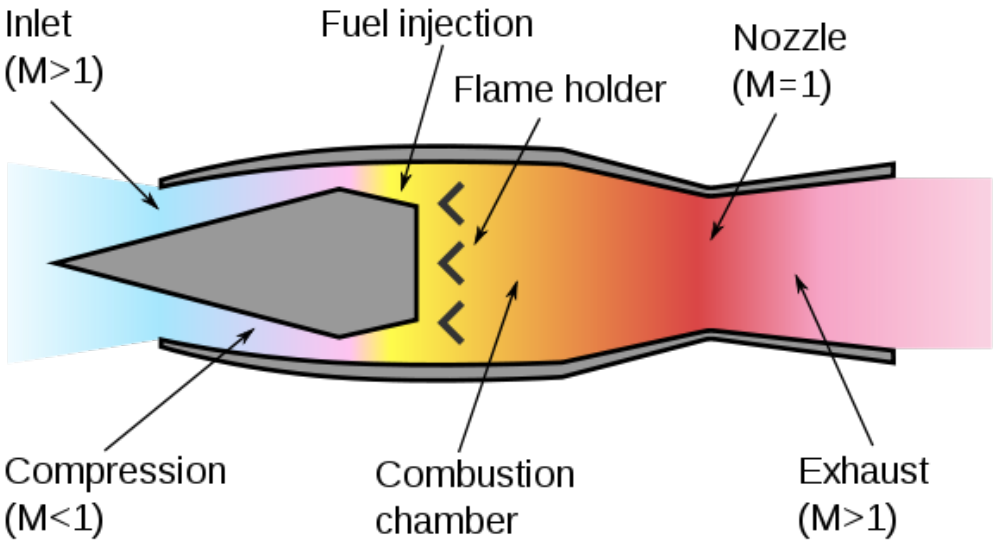
Outline

Area-Velocity Relationship

Isentropic Flow in a Nozzle



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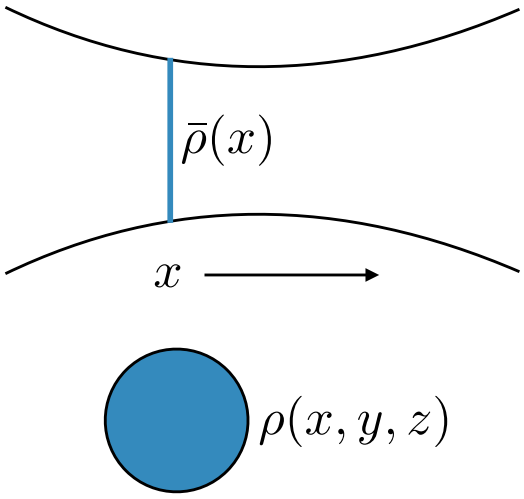
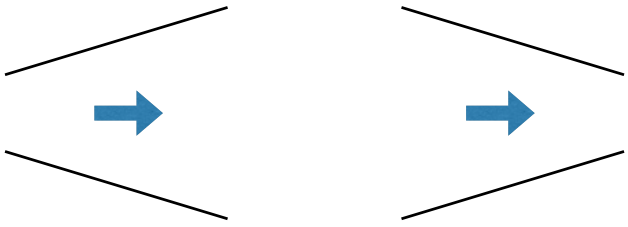
Quasi 1D



Area-Velocity Relationship



subsonic:

supersonic:

Area-Velocity Relationship

Conservation of mass

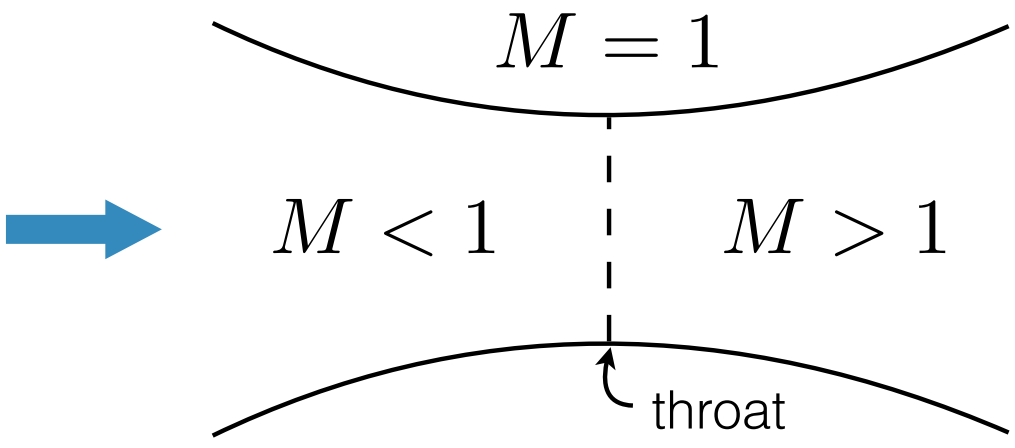
Conservation of momentum (x-dir)

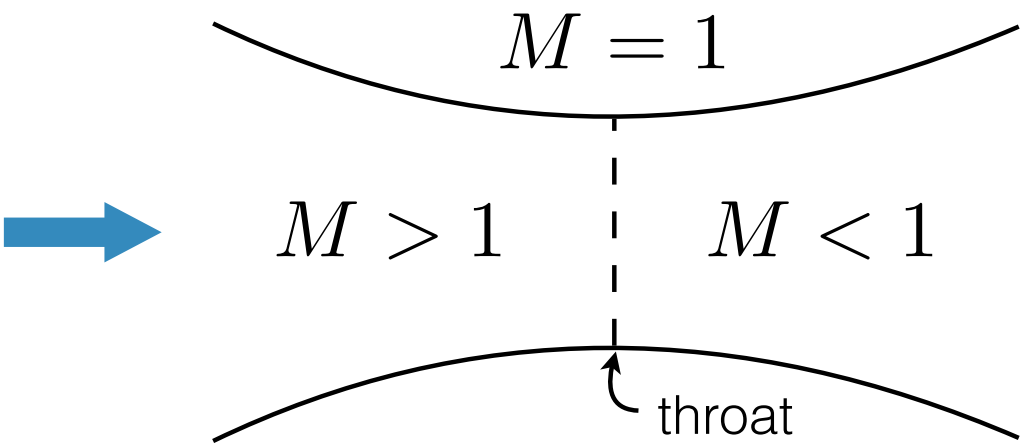
Using our derivation from last time for the speed of sound

$$a = \sqrt{\left(\frac{\partial p}{\partial \rho}\right)_s}$$

we can combine the two equations:

Converging Diverging Nozzle





Video: https://youtu.be/YYNCGZCul1Q

Isentropic Flow in a Nozzle

Isentropic Flow in a Nozzle

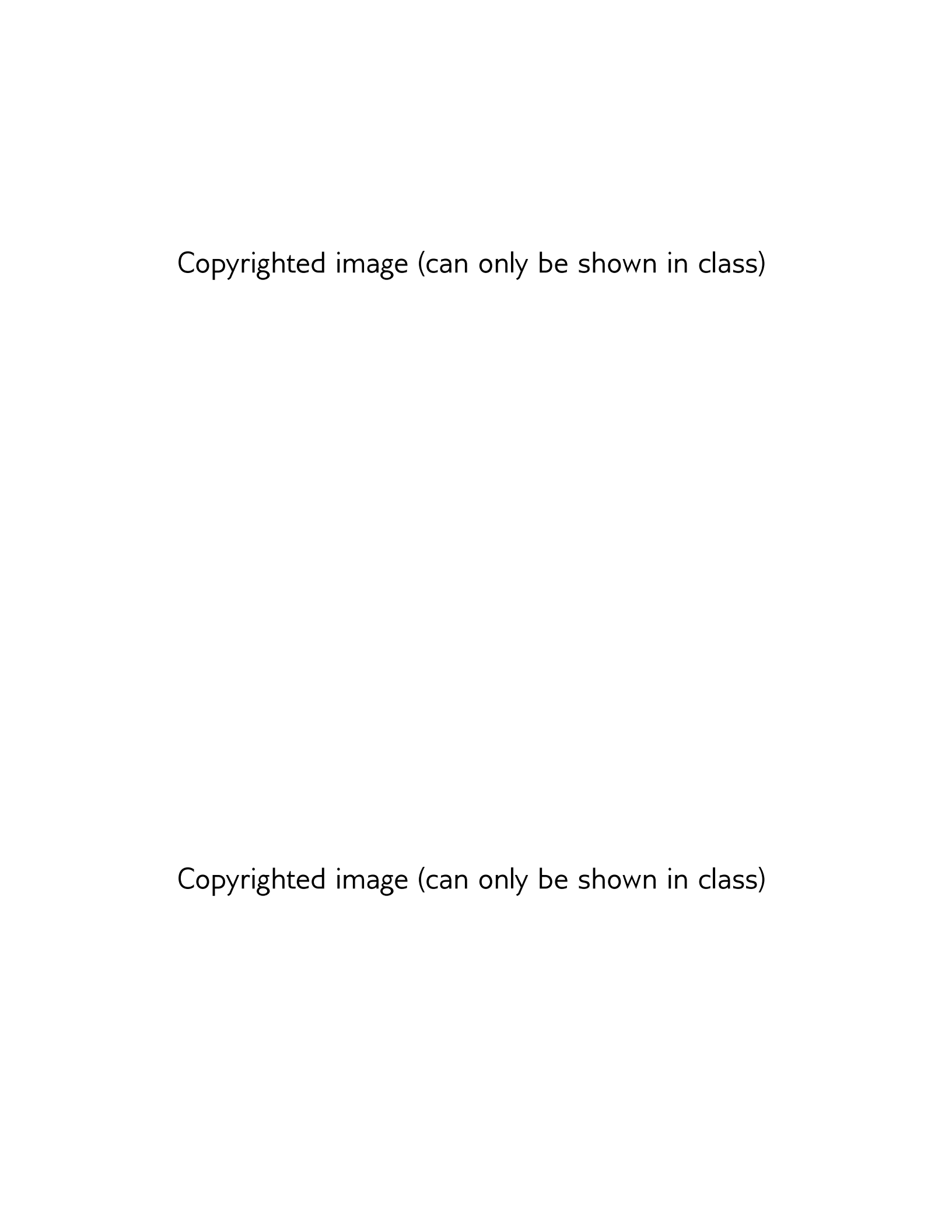
We use the continuity condition to relate continuity from any point to sonic conditions

$$\rho u A = \rho^* u^* A^*$$

Recall the stagnation and isentropic relationships:

Combining yields the area-Mach relationship:

$$\frac{A}{A^*} = \frac{1}{M}\left[\frac{2}{\gamma+1}\left(1+\frac{\gamma-1}{2}M^2\right)\right]^{\frac{\gamma+1}{2(\gamma-1)}}$$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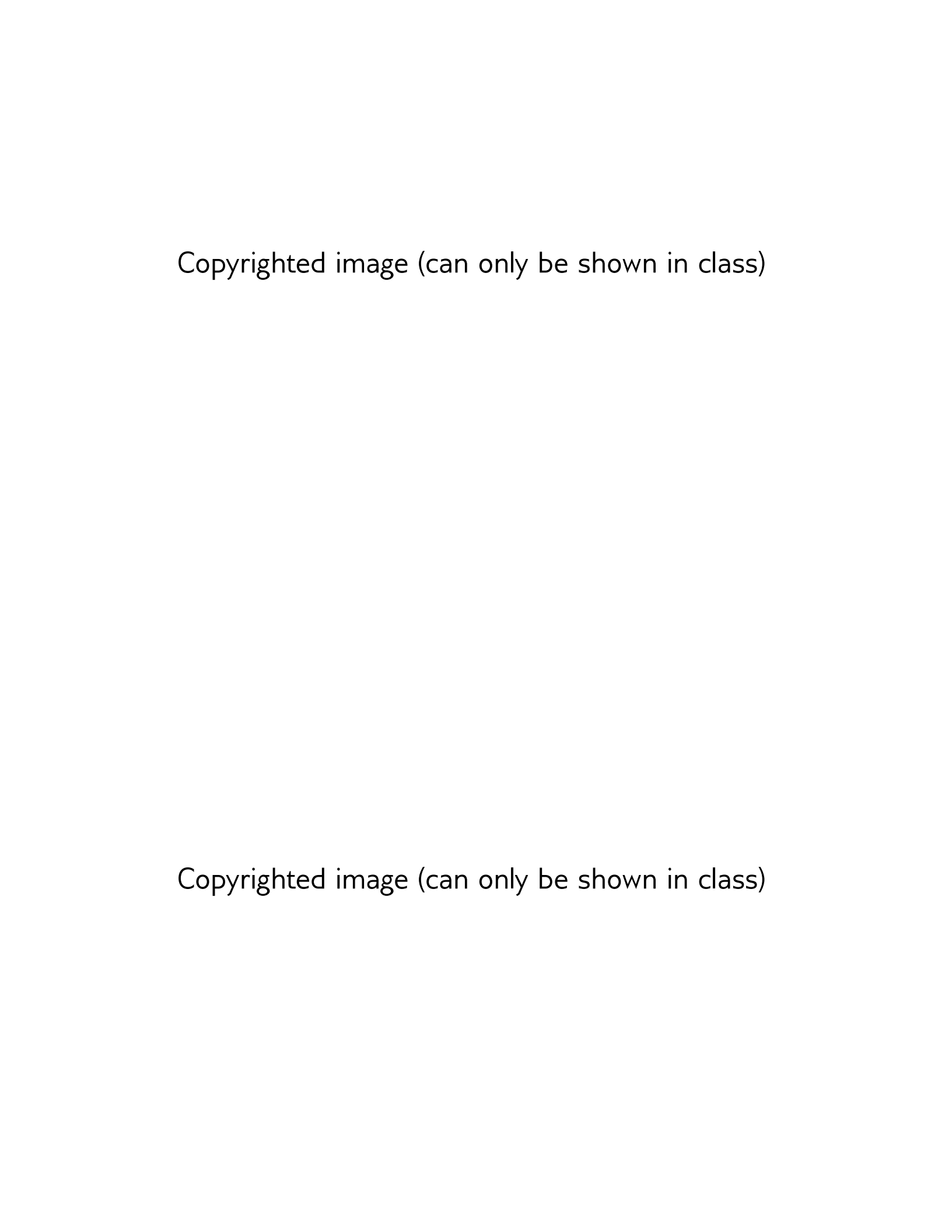
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