REFLECTION, REFRACTION, AND DIFFRACTION (31)

I Main Topics
- A Huygen's Principal
- B Reflection
- C Refraction
- D Diffraction

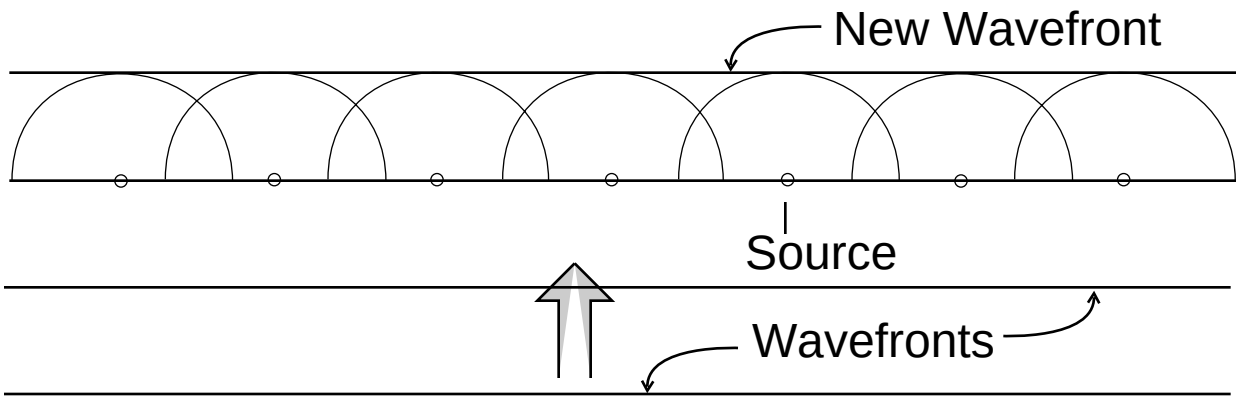
II Huygen's Principal

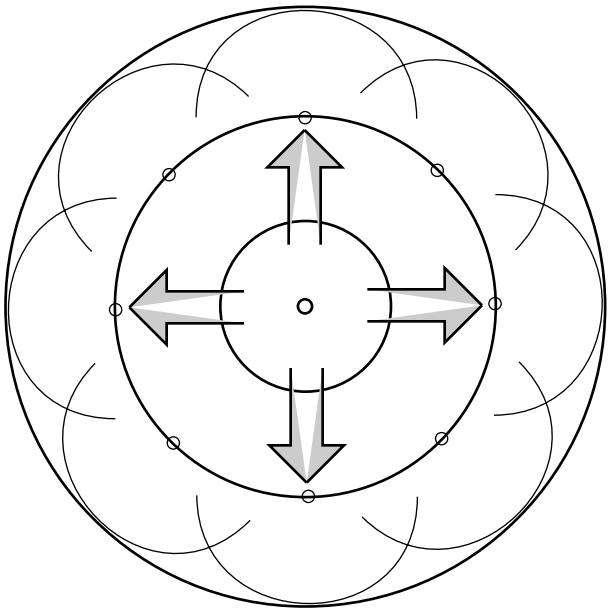
III Reflection: "to ~~bend~~ (bounce) back"
- A Angle of incidence = angle of reflection
- B Waves reflect off vertical walls, not gently sloped beaches

IV Refraction: bending of a wavefront due to changes in its speed
- A Snell's Law
- B Effect of water depth on wave speed
- C Effects of refraction at headlands and in bays
  - 1 Waves concentrate on headlands
  - 2 Waves diverge in bays
- D Ancient Polynesians exploited refraction in exploration!

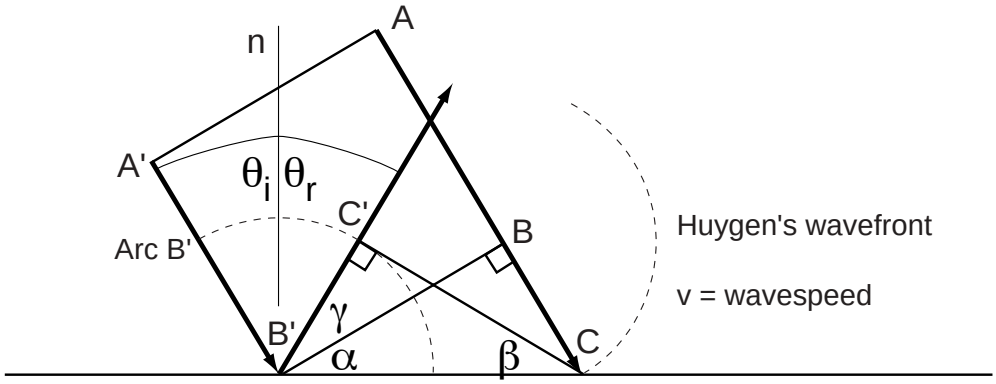
V Diffraction: deflection of waves around obstacles
- A A manifestation of Huygen’s principal
- B Effects of diffraction at breakwaters

HUYGEN'S PRINCIPLE





Reflection of Waves



Consider wavefront AA' that advances to BB' and then to CC'
Ray A'B' | to wavefront B'B because wavefronts are normal to rays
Ray B'C' | to wavefront C'C because wavefronts are normal to rays
(Ray B'C' | to wavefront C'C because CC' is tangent to Arc B')

BC =B'C' = vΔt; B'C = CB'; and both ΔB'BC and ΔCC'B' are right triangles, so

ΔBB'C ~ ΔC'CB'. So angle BB'C (i.e., α) = angle C'CB' (i.e., β).

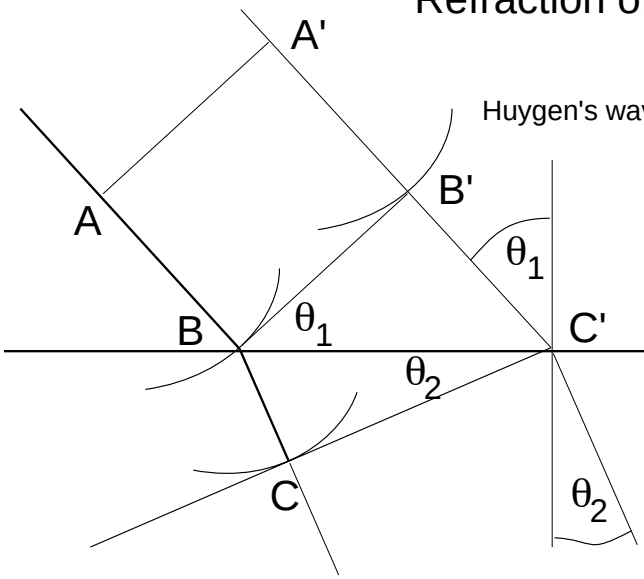
Now A'B' $\perp$ B'B, and nB' $\perp$ B'C, so $\theta_i = \alpha$.

Also, $\alpha+\beta+\gamma = 90^o$, and $\alpha+\gamma+\theta_r = 90^o$, so $\theta_r = \beta$.

Whereas $\alpha = \beta$, $\theta_i = \theta_r$.

The angle of incidence = the angle of reflection.

Refraction of Waves & Snell's Law



"Fast material": $v = v_1$

"Slow material": $v = v_2$

$AB = A'B' = v_1 \Delta t$

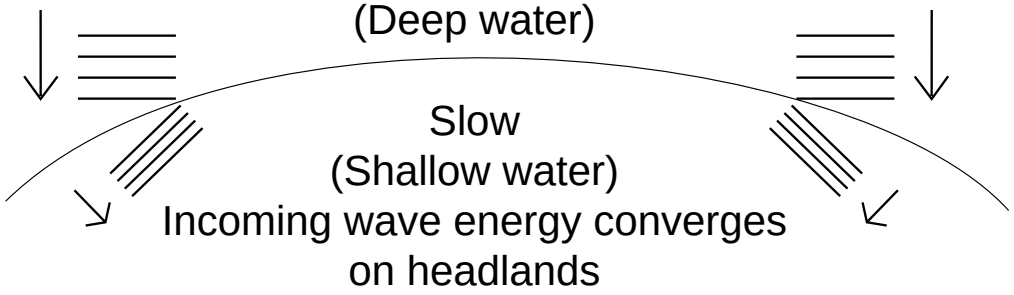
$BC = v_2 \Delta t$; $B'C' = v_1 \Delta t$; $BC < B'C'$

$\sin \theta_1 = B'C'/BC'$; $\sin \theta_2 = BC/BC'$

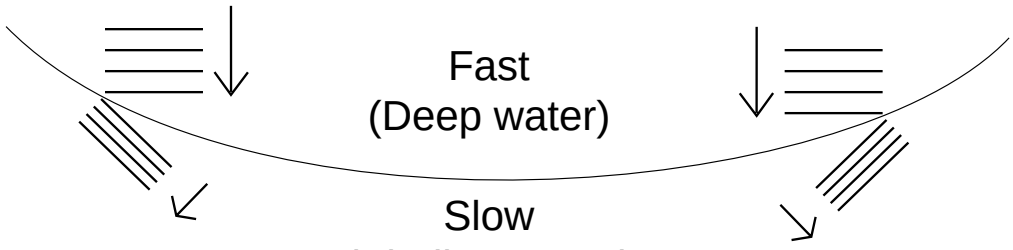
$\sin \theta_1 / \sin \theta_2 = B'C'/C'C' = v_1/v_2$

If $v_1 > v_2$, then $\theta_1 > \theta_2$.

If $v_2 > v_1$, then $\theta_2 > \theta_1$.



Incoming wave energy converges on headlands



Incoming wave energy diverges in bays

DIFFRACTION & REFLECTION