

Standing Oscillations of a Loaded String

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$$A_{r-1} + \left(2 - \frac{ma\omega^2}{T}\right) A_r - A_{r+1} = 0$$

taking $\omega_0^2 = \frac{T}{ma}$

$$\frac{A_{r-1} + A_{r+1}}{A_r} = \left(2 - \frac{ma\omega^2}{T}\right) = \left(2 - \frac{\omega^2}{\omega_0^2}\right)$$

$$= \frac{2\omega_0^2 - \omega^2}{\omega_0^2}$$

Let us express the amplitude of the r-th mass at the frequency ω , as:

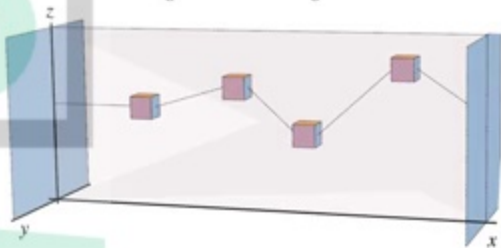
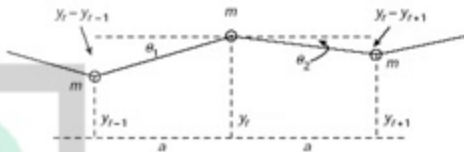
$$A_r = C \sin r \cdot \theta$$

$$A_{r-1} = C \sin (r-1) \theta ; A_{r+1} = C \sin (r+1) \theta$$

$$\frac{A_{r-1} + A_{r+1}}{A_r} = \frac{C \sin (r-1) \theta + C \sin (r+1) \theta}{C \sin r \cdot \theta}$$

$$= \frac{\sin \theta \cos r \theta + \sin r \theta \cos \theta + \sin r \theta \cos \theta + \sin \theta \cos r \theta}{\sin r \theta}$$

$$= 2 \cos \theta$$



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$$A_r = C \sin r \cdot \theta$$

$$A_{r-1} = C \sin (r-1) \theta ; A_{r+1} = C \sin (r+1) \theta$$

To find θ_s at w_s , we apply the boundary conditions:

$$A_0 = 0 ; A_{n+1} = 0$$

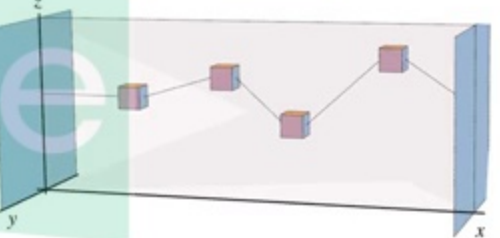
$$A_0 = C \sin 0 \cdot \theta = 0$$

$$A_{n+1} = C \sin (n+1) \theta = 0 \Rightarrow (n+1) \theta_s = s \pi$$

$$s = 1, 2, 3, 4, \dots, n$$

$$\Rightarrow \theta_s = \frac{s \pi}{(n+1)}$$

$$A_{rs} = C_s \sin \frac{s \pi}{(n+1)} \cdot r$$



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