Linear Superposition and Interference

**Linear Superposition:**

*The Principle of Linear Superposition:* when two or more waves are present at the same place at the same time, the resultant disturbance is the sum of the disturbances from the individual waves

⇒ for 2 wave sources vibrating in phase:

\[ \Delta L = n\lambda \quad n = 0, 1, 2, \ldots \quad \text{constructive interference} \]
\[ \Delta L = \frac{n\lambda}{2} \quad n = 1, 3, 5, \ldots \quad \text{destructive interference} \]

**Beats:**

\[ f_{\text{beats}} = |f_1 - f_2| \]

**Standing Waves:**

⇒ for standing waves on a string fixed at both ends:

\[ \lambda = \frac{2L}{n} \quad f_n = n\left(\frac{v}{2L}\right) \quad n = 1, 2, 3, \ldots \]

⇒ for standing waves in a tube open at both ends:

\[ \lambda = \frac{2L}{n} \quad f_n = n\left(\frac{v}{2L}\right) \quad n = 1, 2, 3, \ldots \]

⇒ for standing waves in a tube open at only one end:

\[ \lambda = \frac{4L}{n} \quad f_n = n\left(\frac{v}{4L}\right) \quad n = 1, 3, 5, \ldots \]