string as rotating rod

\[ x = \frac{L}{2} \sin \phi \quad \text{and} \quad \phi = \frac{\pi}{2} \]

\[ v = c \sin \phi \]

string constant

\[ E = \int_{\frac{L}{2}}^{L} \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{1}{2} RP \int_{\frac{\pi}{c}}^{\frac{\pi}{c}} \frac{\sin \phi \, d \phi}{\cos \phi} \]

\[ = \frac{\pi R^2}{2} \]

Angular momentum

\[ L = \int x \sigma (x) \frac{dx}{c^2} \]

\[ \sqrt{1 - \frac{v^2}{c^2}} \]

\[ = \frac{1}{2} RP \int_{\frac{\pi}{c}}^{\frac{\pi}{c}} \frac{\sin \phi \, d \phi}{\cos \phi} \]

\[ = \frac{\pi R^2}{c} = \frac{E^2}{2 \mu c^2} \]

\[ \Rightarrow L = \frac{2}{c} E^2 \text{ with } \frac{1}{c^2 \mu} \]

additional factor \( T \) with respect to the previous argument.