We have found the shape of the orbits. We still need to get them as functions of the time. From energy conservation, we have

\[ E = \frac{m}{2} (\dot{r})^2 + \frac{\sigma}{r^2} \quad \text{where} \quad \sigma = \frac{L^2}{2m} + \lambda. \]

\[ \dot{r}^2 = \frac{2E}{m} - \frac{2\sigma}{m} \frac{1}{r^2} \implies \dot{r} = \sqrt{\frac{2E}{m} - \frac{2\sigma}{m} \frac{1}{r^2}} \]

**First suppose** \( \sigma > 0 \)

For the effective potential, we have

\[ V_{\text{eff}} \]

\[ E \]

\[ r_{\text{min}} = R \]

So in this case there is a turning point at \( r = R \) where

\[ \frac{2E}{m} = \frac{2\sigma}{m} \frac{1}{R^2} \]