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For $E < 0$ the solution is $u = \frac{1}{R}\cosh[\Omega(\theta-\theta_0)]$

$$\Rightarrow \frac{du}{d\theta} = -\frac{\Omega}{R}\sinh[\Omega(\theta-\theta_0)] \Rightarrow$$

$$\left(\frac{du}{d\theta}\right)^2 - \Omega^2 u = \frac{\Omega^2}{R^2}\left[\sinh^2 - \cosh^2\right] = -\frac{\Omega^2}{R^2} < 0.$$

Thus, in this case $r = 1/u \Rightarrow$

$$\boxed{r = \frac{R}{\cosh[\Omega(\theta-\theta_0)]}}$$

In this case the orbit spirals out of the origin as θ increases from $-\infty$, reaches $r = R$ when $\theta = \theta_0$, and spirals back in as $\theta \to +\infty$.