distance between the two bodies

$$E = \frac{1}{2\mu}(\partial_t r)^2 + U_{eff}(r)$$

$l^2/(2\mu r^2)$

$E > 0 \Rightarrow$ hyperbola

$E = 0 \Rightarrow$ parabola

$E < 0 \Rightarrow$ ellipse

r_{max}

r_{min}

r

$-\alpha/r$

$U_{eff}(r)$

point of reversal
where $\partial_t r = 0$

r = const.
(circular orbit)