

$$F = \frac{Gm_1m_2}{r^2}$$

$$\ddot{\vec{r}} = -\frac{G(m_1+m_2)}{r^2}\hat{r}$$

$$\ddot{\vec{r}} = -\frac{1+q}{r^2}\hat{r}$$

$$\ddot{x} = -\frac{1+q}{r^3}x$$

$$\ddot{y} = -\frac{1+q}{r^3}y$$

$$u_1 = x$$

$$u_2 = y$$

$$u_3 = \dot{x}$$

$$u_4 = \dot{y}$$

$$\dot{u}_1 = u_3$$

$$\dot{u}_2 = u_4$$

$$\dot{u}_3 = -\frac{1+q}{r^3}u_1$$

$$\dot{u}_4 = -\frac{1+q}{r^3}u_2$$