f)

* $\dot{r} = \frac{p_r}{m}$

$$\left.\begin{aligned} \frac{\dot{r}}{d} &= \frac{p_r}{m d} \end{aligned}\right\} \quad \dot{\tilde{r}} = \tilde{p}_r$$

* $\dot{\phi} = \frac{p_\phi}{m r^2}$ $\qquad \tilde{r} d = r$

$p_\phi = \tilde{p}_\phi m d^2$

$$\left.\begin{aligned} \dot{\phi} &= \frac{\tilde{p}_\phi \cancel{m} d^2}{\cancel{m} \tilde{r}^2 d^2} \end{aligned}\right\} \quad \frac{\tilde{p}_\phi}{\tilde{r}^2}$$

*

$$\dot{\tilde{p}}_r = \frac{\tilde{p}_\phi^2 d^3}{r^3} - G\frac{M_t}{\tilde{r}^2 d^3} - G\frac{\left(\frac{M \cdot M_t}{d^2 M_t}\right)}{\left(\frac{\sqrt{r^2+d^2-2rd\cos(\phi-\omega t)}}{d}\right)^3}\left(\tilde{r} - \cos(\phi-\omega t)\right)$$

$$= \frac{\tilde{p}_\phi^2 d^3}{r^3} - G\frac{M_t}{d^3}\left(\frac{1}{\tilde{r}^2} - \frac{M(\tilde{r}-\cos(\phi-\omega t))}{\sqrt{(r^2+1-2\tilde{r}\cos(\phi-\omega t)}^3 M_t}\right)$$

$$\dot{\tilde{p}}_r = \frac{\tilde{p}_\phi^2 d^3}{\tilde{r}^3} - \Delta\left(\frac{1}{\tilde{r}^2} - \frac{M(\tilde{r}-\cos(\phi-\omega t))}{\tilde{r}^3}\right)$$

*

$$\frac{\dot{p}_\phi}{m d^2} = -G\frac{m M_t}{r^3} r d \sin(\phi-\omega t)$$

$$\dot{\tilde{p}}_\phi = -G\frac{(M M_t / m_t)}{r^3 d^2}\tilde{r}\sin(\phi-\omega t)$$

$$\dot{\tilde{p}}_\phi = -G\frac{(m M_t / m_t d^3)}{\sqrt{(r^2+1-2\tilde{r}\cos(\phi-\omega t)}^3}\tilde{r}\sin(\phi-\omega t)$$

$$\dot{\tilde{p}}_\phi = -\Delta\frac{M}{\tilde{r}^3}\tilde{r}\sin(\phi-\omega t)$$