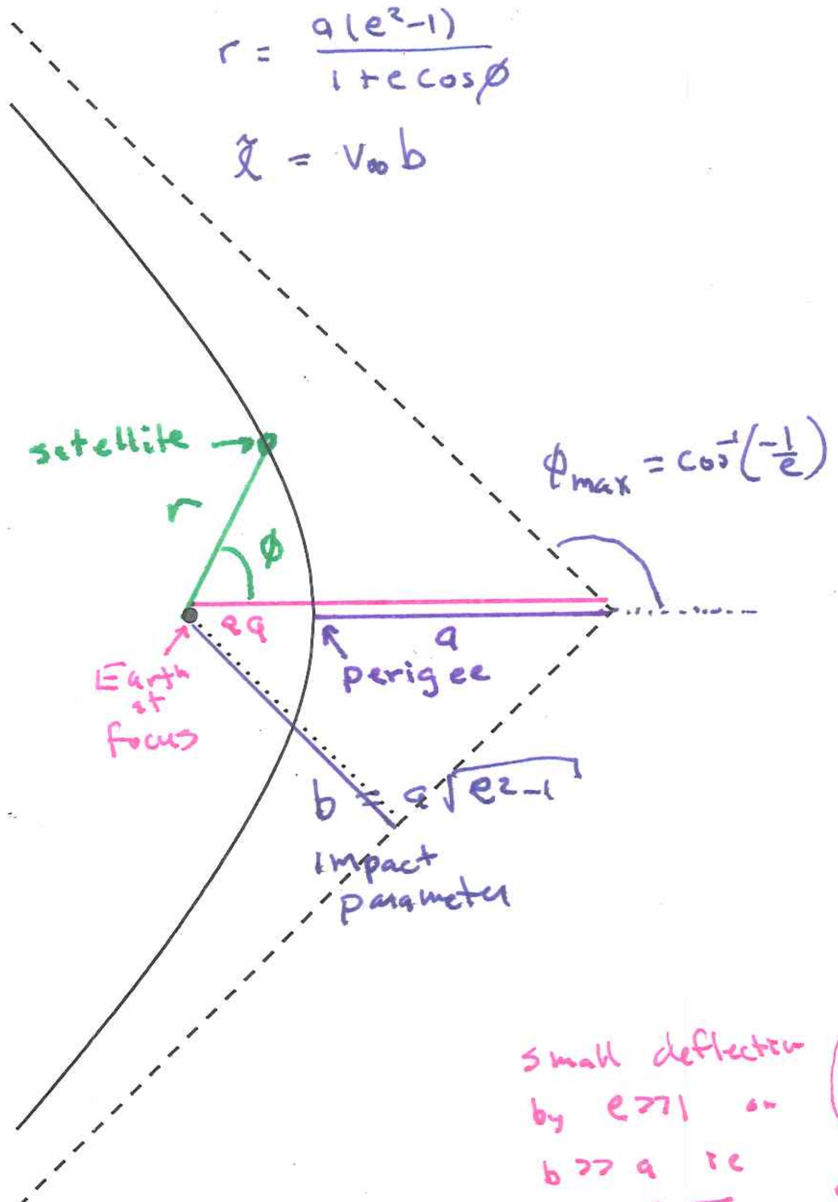
$$\frac{2E}{\mu} = \frac{\alpha/\mu}{a} = V_\infty^2$$

$$r = \frac{a(e^2-1)}{1+e\cos\phi}$$

$$\tilde{\ell} = V_\infty b$$



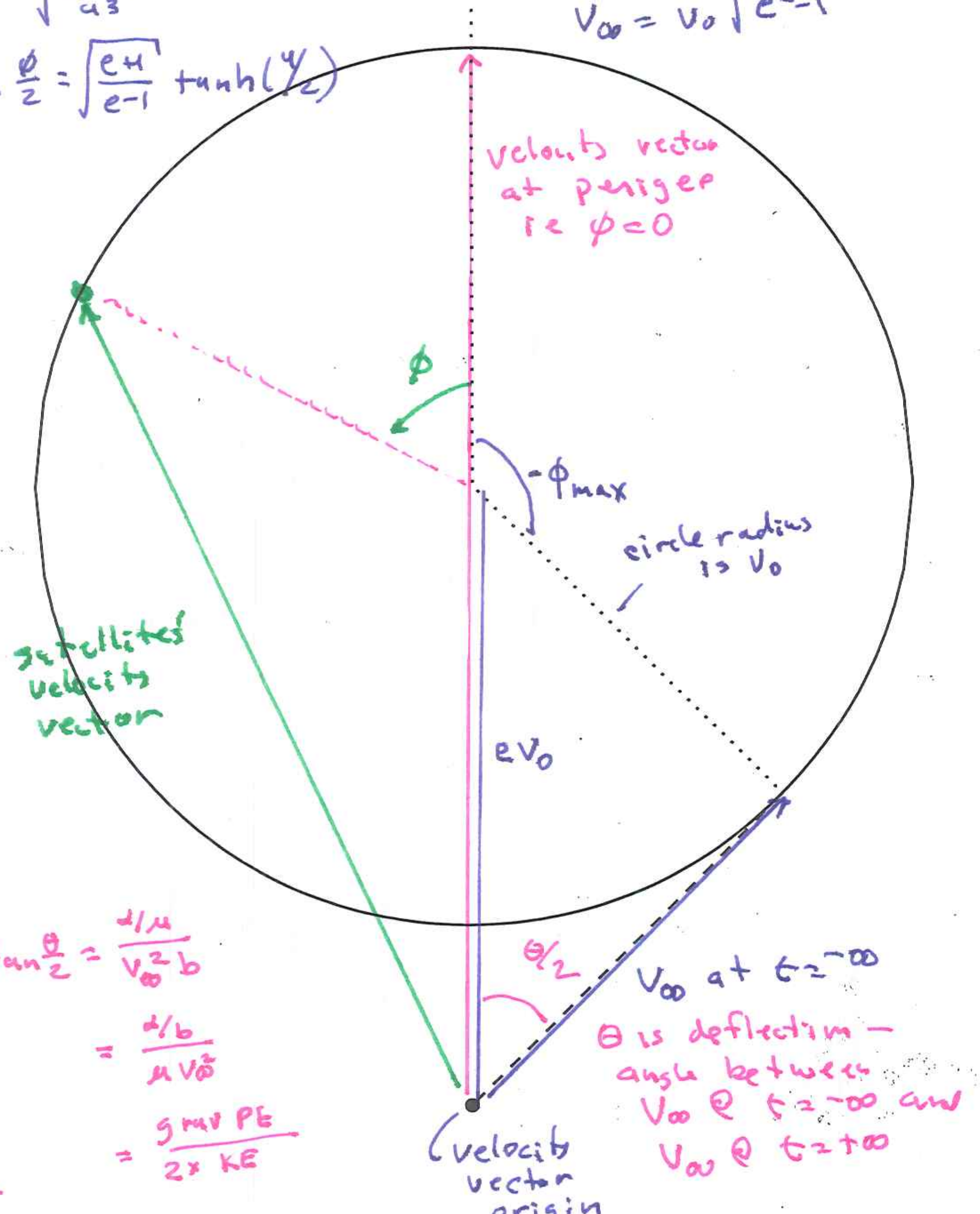
$$\omega t = e\sinh u - u$$

$$\omega = \sqrt{\frac{\alpha/\mu}{a^3}}$$

$$\tan\frac{\phi}{2} = \sqrt{\frac{e+1}{e-1}}\tanh(u/2)$$

$$V_0 = \frac{\alpha/\mu}{\tilde{\ell}}$$

$$V_\infty = V_0\sqrt{e^2-1}$$



small deflection by $e \gg 1$ or $b \gg a$ ie "large" T_∞

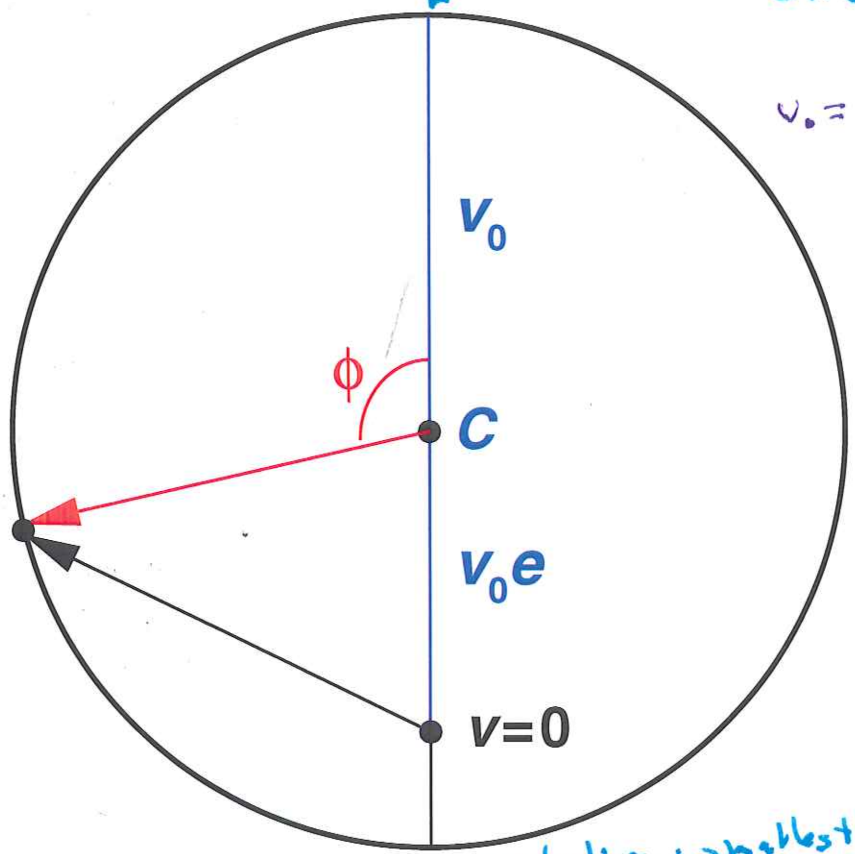
$$\tan\frac{\theta}{2} = \frac{\alpha/\mu}{V_\infty^2 b} = \frac{\alpha/b}{\mu V_\infty^2} = \frac{\text{grav PE}}{2\times \text{KE}}$$

Note: For gravity $\frac{\alpha}{\mu} = GM$; diagrams are for $e=\sqrt{2}$

$\phi = 0$

perihelion: largest velocity is in +y direction

$$v_0 = \sqrt{\frac{\alpha}{\mu a(1-e^2)}}$$



aphelion: smallest velocity in −y direction

$\phi = 180°$

from center

eccentric anomaly

$$\vec{r} = (a\cos u,\ b\sin u)$$

$$b = a\sqrt{1-e^2}$$

$$\tan\frac{\phi}{2} = \sqrt{\frac{1+e}{1-e}}\tan\frac{u}{2}$$

$$u - e\sin u = \underbrace{\omega t}_{\text{mean anomaly}}$$

ϕ = true anomaly

a = semi major axis

b = semi minor axis

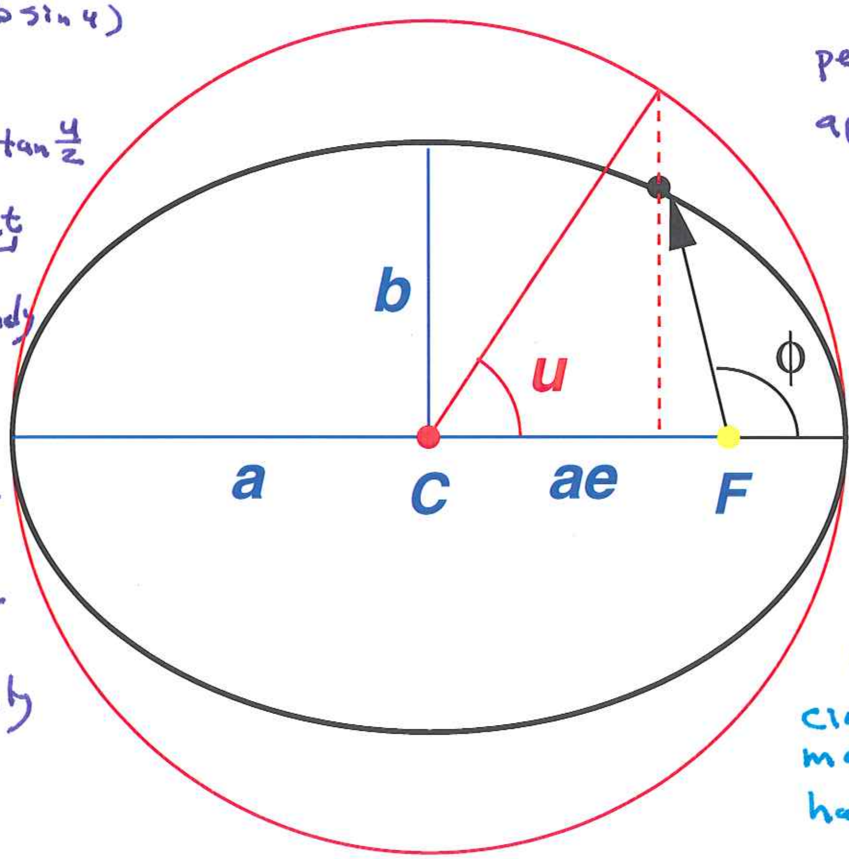
e = eccentricity

from focus

$$r = \frac{a(1-e^2)}{1+e\cos\phi}$$

$$\text{peri} = r_{min} = a(1-e)$$

$$\text{apo} = r_{max} = a(1+e)$$



$$\left.\begin{array}{l} \omega = \sqrt{\dfrac{\alpha}{\mu a^3}} \\[2ex] E = \dfrac{-\alpha}{2a} \end{array}\right\}\ \text{do not depend on eccentricity}$$

$$L = \sqrt{\alpha\mu a(1-e^2)}$$

circular orbits ($e=0$) have max L; line orbits ($e=1$) have min L