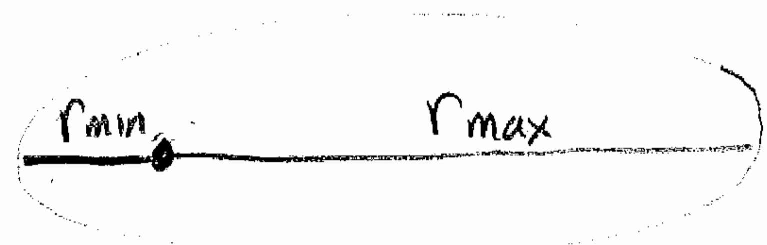


$$B = \frac{2r_0}{\sqrt{1-\varepsilon^2}}$$

$$A = \frac{r_0}{1+\varepsilon} + \frac{r_0}{1-\varepsilon}$$

$$\frac{r_0(1-\varepsilon) + r(1+\varepsilon)}{(1-\varepsilon^2)}$$

$$= \frac{2r_0}{1-\varepsilon^2}$$

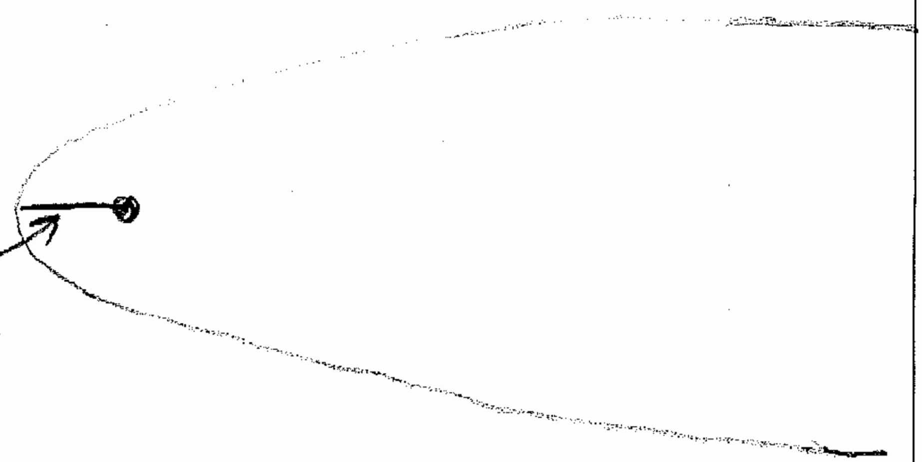
not proved hear

(3) Parabolic Orbit..

$$\varepsilon = 1 \rightarrow \frac{1}{2}\mu \dot{r}^2 = |E_c|$$

$$E_{tot} = 0$$

$$r = \frac{r_0}{1-\cos\theta}$$



$\frac{1}{2} r_0$

(4) Hyperbolic Orbit...

$$E_{tot} > 0$$

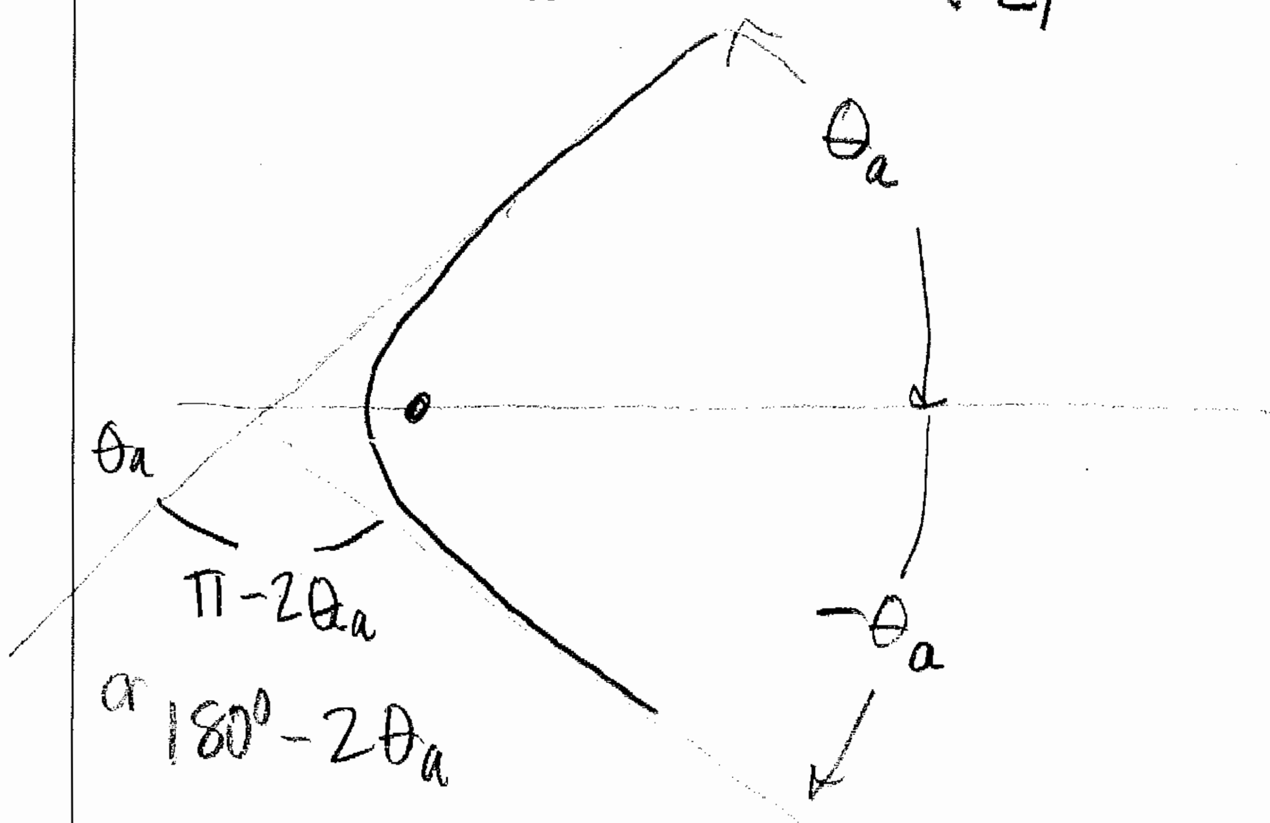
$$\varepsilon > 1$$

$$r = \frac{r_0}{1 - \varepsilon\cos\theta} \leftarrow \underset{\text{when}}{r \to \infty}$$

asymptote $\rightarrow$ $1 - \varepsilon\cos\theta_a = 0$

$$\cos\theta_a = \frac{1}{\varepsilon}$$

$$\theta_a = \pm\cos^{-1}\left(\frac{1}{\varepsilon}\right)$$



Kepler's Laws

1. Each Planet Moves in an Ellipse with Sun at One Focus

$$r = \frac{r_0}{1 - \varepsilon \cos\theta}$$

→ origin is focus

→ note 9.1

- only true in approximation Sun infinitely massive.

Actually: both do ellipses about COM

light blue shifted!

That is how extrasolar planets discovered.

2. Radius: equal areas in equal times (conservation of Angular momentum)

3. $T^2 \propto A^3$ $\quad$ A = major axis of ellipse.

$\boxed{\text{Complex Numbers}}$

$i \equiv \sqrt{-1} \qquad i^2 = -1$ "imaginary number"

Can add this to a real number.

complex # $z = x + iy$

x and y are real numbers

$Re(z) = x$
$Im(z) = y$

$\boxed{\text{Complex conjugation}}$

definition: $z^* = (x+iy)^* = x^* + (iy)^*$

$$= x^* + i^* y^*$$

real numbers: $x^* \equiv x$, $y^* \equiv y$

imaginary numbers $i^* = -i$

$$\text{so} \quad \left.\begin{aligned} z &= x + iy \\ z^* &= x - iy \end{aligned}\right\}$$

$z + z^* = 2Re(z) = 2x$
$z - z^* = 2i\,Im(z) = 2iy$

$$z \cdot z^* = z^* \cdot z = (x+iy)(x-iy)$$

$$= x^2 + \cancel{iyx} - \cancel{ixy} + (iy)(-iy)$$

$$zz^* = \underbrace{x^2+y^2} = |z|^2 \text{ is real}$$

like magnitude of a vector, squared

$$\sqrt{x^2+y^2} = |z|$$