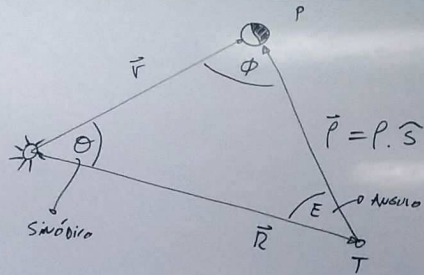


MOVIMIENTO APARENTE PLANETARIO (órbitas circulares:  
 $\vec{R} = r_m \cdot \hat{R}$ ,  $\vec{F} = a \cdot \hat{F}$ )



$\phi = \text{ÁNGULO DE FASE}$

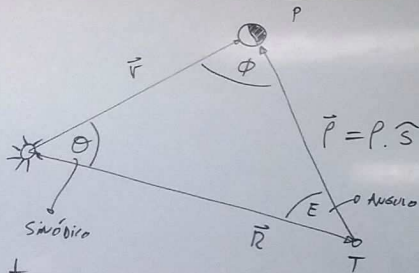
$$\vec{P} \cdot \vec{F} = P \cdot r \cdot \cos \phi$$

$$-\vec{R} \cdot \vec{P} = R \cdot P \cdot \cos E$$

$$\vec{P} = P \cdot \hat{S}$$

ÁNGULO

MOVIMIENTO APARENTE PLANETARIO (ÓRBITAS CIRCULARES)  
 $\vec{r} = r \cdot \hat{r}$



$\phi = \text{ÁNGULO DE FASE}$

$$\vec{p} \cdot \vec{r} = p \cdot r \cdot \cos \theta$$

$$-R \cdot \vec{p} = R \cdot \vec{p}$$

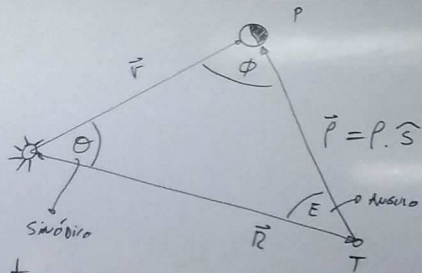
$$\vec{p} = p \cdot \hat{s}$$

$$\theta(t) \propto t$$

$$m = \sqrt{r/a^3} = k/a^2 \quad \mu = k^2 (m_0 + m_1) \approx k^2$$

↑ Vel. Angular  
RADS/DIA

MOVIMENTO APARENTE PLANETARIO (órbitas circulares:  
 $\vec{r} = r \cdot \hat{R}$ ,  $\vec{F} = a \cdot \hat{F}$ )



$\phi = \text{ÁNGULO DE FASE}$

$$\vec{P} \cdot \vec{F} = P \cdot r \cdot \cos \phi$$

$$-\vec{R} \cdot \vec{P} = R \cdot P \cdot \cos E$$

$$\vec{P} = P \cdot \hat{S}$$

$$\theta(t) \propto t$$

$$\dot{\theta} = \frac{2\pi}{S} - \frac{2\pi}{T_p} \Rightarrow \frac{1}{S} = \frac{1}{T_p} - 1$$

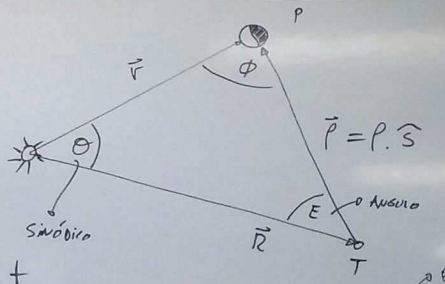
(EN APÓS)

$$M = \sqrt{r/a^3} = \frac{h}{a^2 v} \quad \mu = h^2 (m_0 + m_1) \approx h^2$$

↑ VEL. ANGULAR  
RADS/DIA

S = PERÍODO SINOÓDICO

MOVIMIENTO APARENTE PLANETARIO (órbitas circulares:  $\vec{r} = r \cdot \hat{R}$ ,  $\vec{F} = a \cdot \hat{F}$ )



$\phi = \text{ÁNGULO DE FASE}$

$\vec{P} \cdot \vec{F} = P \cdot r \cdot \cos \phi$

$-\vec{R} \cdot \vec{P} = R \cdot P \cdot \cos E$

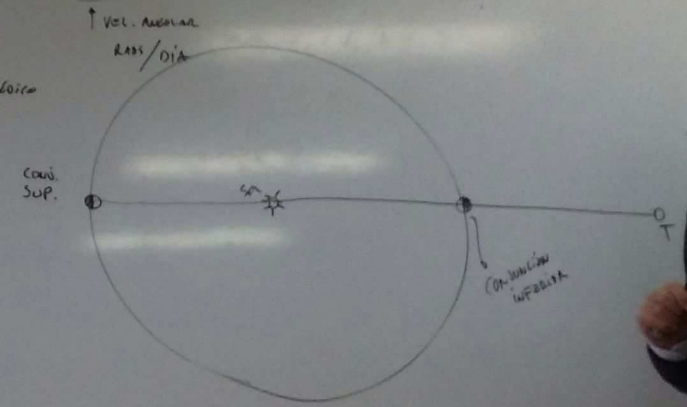
$\vec{P} = P \cdot \hat{S}$

$\theta(t) \propto t$

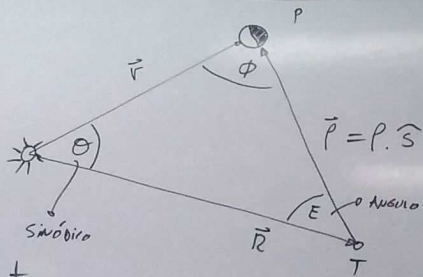
$\dot{\theta} = m_p - m_t = \frac{2\pi}{T_p} - \frac{2\pi}{1 \text{ año}} \Rightarrow \frac{1}{S} = \frac{1}{T_p} - 1$

$m = \sqrt{r/a^3} = k/a^m$       $\mu = k^2(m_0 + m) \approx k^2$

S = Período sideral



MOVIMIENTO APARENTE PLANETARIO (órbitas circulares:  $\vec{r} = r \cdot \hat{r}, \vec{v} = a \cdot \hat{v}$ )



$\phi = \text{ÁNGULO DE FASE}$

$\vec{P} \cdot \vec{v} = P \cdot v \cdot \cos \phi$

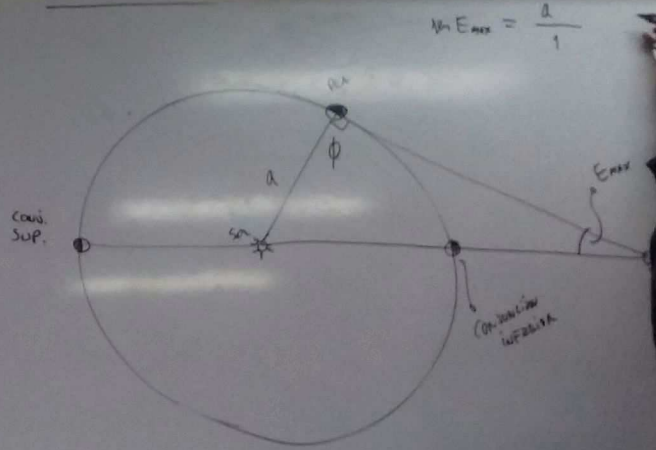
$-\vec{R} \cdot \vec{P} = R \cdot P \cdot \cos E$

$\vec{P} = P \cdot \hat{s}$

$\theta(t) \propto t$

$\dot{\theta} = m_p - m_t = \frac{2\pi}{T_p} - \frac{2\pi}{1 \text{ año}} \Rightarrow \frac{1}{S} = \frac{1}{T_p} - 1$

PLANETA INFERIOR



$\sin E_{max} = \frac{a}{1}$





MOVIMIENTO APARENTE PLANETARIO (órbitas circulares:  
 $\vec{R} = r_m \cdot \hat{R}, \vec{F} = a \cdot \hat{F}$ )

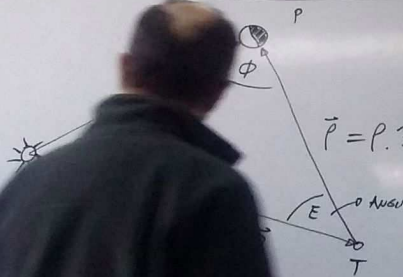
$\phi = \text{ÁNGULO DE FASE}$

$\vec{P} \cdot \vec{F} = P \cdot r \cdot \cos \phi$   
 $-\vec{R} \cdot \vec{P} = R \cdot P \cdot \cos E$

$\vec{P} = P \cdot \hat{S}$

$\Rightarrow \frac{1}{S} = \frac{1}{T_p} - 1$

*EN AÑOS*



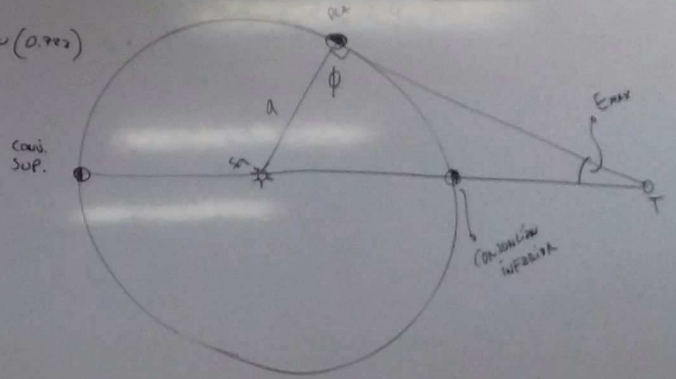
$\theta(t)$   
 $\dot{\theta}$   
 $\frac{2\pi}{S}$

PLANETA INTERIOR

VENUS:  $a = 0.723 \text{ UA}$

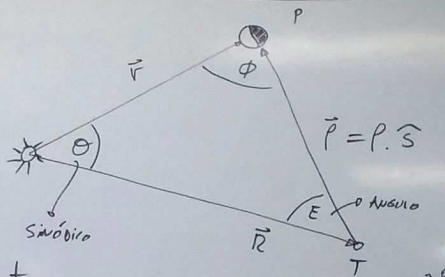
$\Rightarrow E_{\text{max}} = \text{ARCO}(0.723)$   
 $46^\circ$

$E_{\text{max}} = \frac{a}{1}$



$\frac{2\pi}{S}$

MOVIMIENTO APARENTE PLANETARIO (ÓRBITAS CIRCULARES:  $\vec{R} = 1 \text{ u.} \cdot \hat{R}$ ,  $\vec{F} = a \cdot \hat{F}$ )



$\phi = \text{ÁNGULO DE FASE}$

$\vec{P} \cdot \vec{F} = P \cdot F \cdot \cos \phi$

$\vec{P} = P \cdot \hat{S}$

$-\vec{R} \cdot \vec{P} = R \cdot P \cdot \cos E$

$\theta(t) \propto t$

$\dot{\theta} = m_p - m_t = \frac{2\pi}{T_p} - \frac{2\pi}{1 \text{ año}} \Rightarrow \frac{1}{S} = \frac{1}{T_p} - 1$

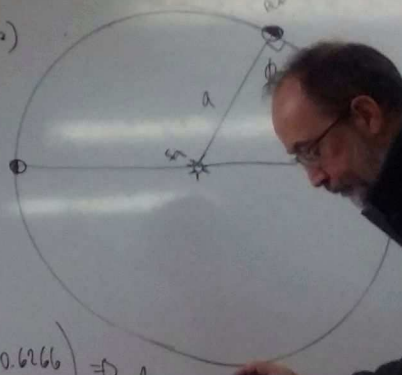
PLANETA INTERIOR

VENUS:  $a = 0.723 \text{ u.}$

$\frac{1}{S} E_{\text{max}} = \frac{a}{1}$

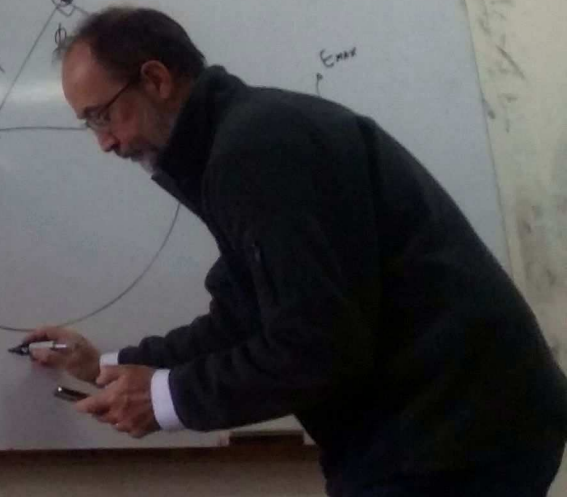
$\Rightarrow E_{\text{max}} = \text{ARCSIN}(0.723)$

46°

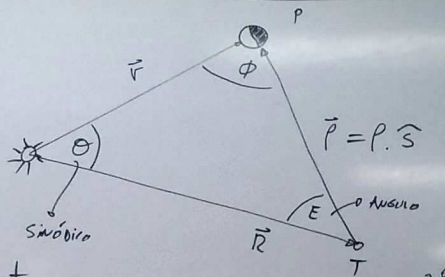


$\frac{2\pi}{S} = \frac{k}{a^3} - \frac{k}{1}$

$\frac{2\pi}{S} = \frac{k}{0.723^3} - k = k(0.6266) \Rightarrow \frac{1}{S} =$



MOVIMIENTO APARENTE PLANETARIO (órbitas circulares:  $\vec{R} = r_m \cdot \hat{R}$ ,  $\vec{F} = a \cdot \hat{F}$ )



$\phi = \text{ángulo de fase}$

$\vec{P} \cdot \vec{F} = P \cdot r \cdot \cos \phi$

$-\vec{R} \cdot \vec{P} = R \cdot P \cdot \cos E$

$\vec{P} = P \cdot \hat{S}$

$\theta(t) \propto t$

$\dot{\theta} = m_p - m_t = \frac{2\pi}{T_p} - \frac{2\pi}{1 \text{ año}} \Rightarrow \frac{1}{S} = \frac{1}{T_p} - 1$

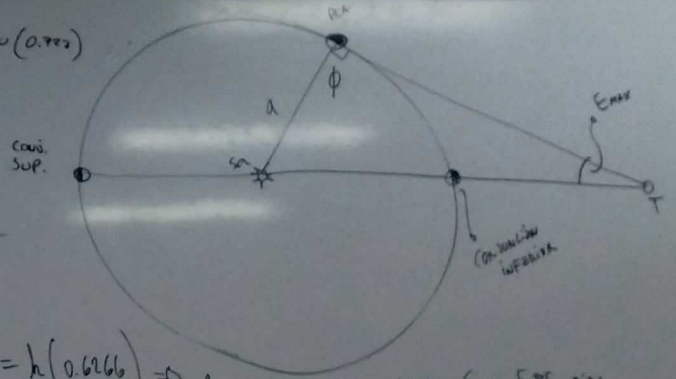
PLANETA INTERIOR

VENUS:  $a = 0.723 \text{ UA}$

$\frac{1}{S} E_{\text{max}} = \frac{a}{1}$

$E_{\text{max}} = \arcsin(0.723)$

46°

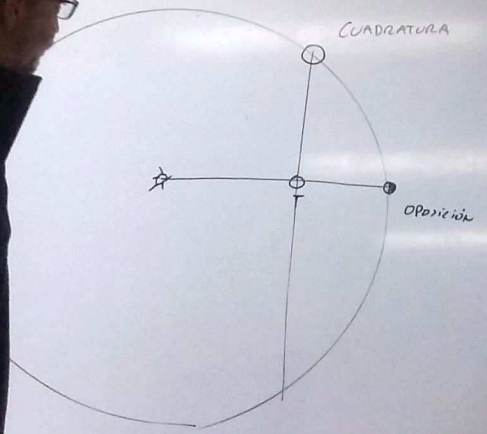


$\frac{2\pi}{S} = \frac{h}{a^2} - \frac{h}{1}$

$\frac{2\pi}{S} = \frac{h}{0.723^2} - h = h(0.6266) \Rightarrow \frac{1}{S} = 1.7 \times 10^{-3} \text{ día}^{-1} \Rightarrow S = 585 \text{ días}$



FENÓMENO APARENTE PLANETARIO (órbitas circulares:  
 $\vec{r} = r_m \cdot \hat{r}, \vec{v} = a \cdot \hat{v}$ )

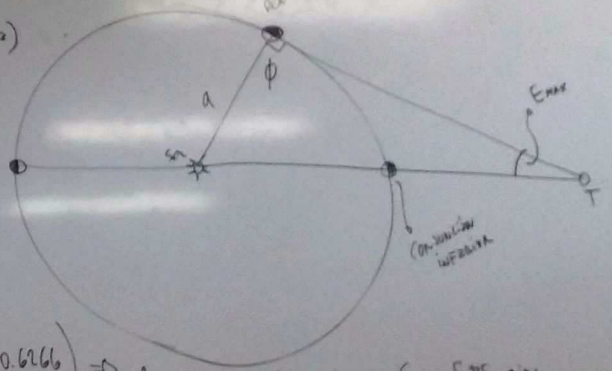


PLANETA INFERIOR

VENUS:  $a = 0.723 \text{ ua}$

$$\frac{1}{2} E_{\max} = \frac{a}{1}$$

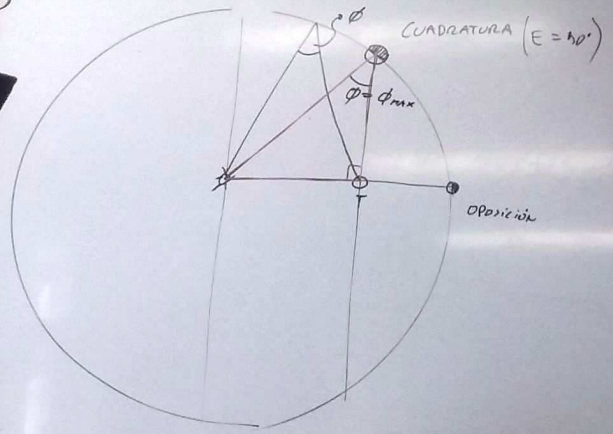
$\Rightarrow E_{\max} = \text{ARCO}(0.723)$   
 $46^\circ$



$$\frac{2\pi}{S} = \frac{k}{a^3} - \frac{k}{1}$$

$\frac{2\pi}{S} = \frac{k}{0.723^3} - k = k(0.6266) \Rightarrow \frac{1}{S} = 1.7 \times 10^{-3} \text{ día}^{-1} \Rightarrow S = 585 \text{ días}$

MOVIMIENTO APARENTE PLANETARIO ( ÓRBITAS CIRCULARES:  
 $\vec{R} = 1 \text{ u. } \hat{R}, \vec{F} = a \cdot \hat{F}$ )



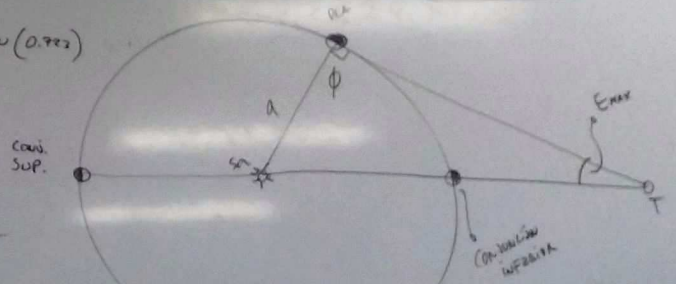
PLANETA INTERIOR

VENUS:  $a = 0.723 \text{ u.}$

$$\sin E_{max} = \frac{a}{1}$$

$$\Rightarrow E_{max} = \text{ARCSIN}(0.723)$$

46°

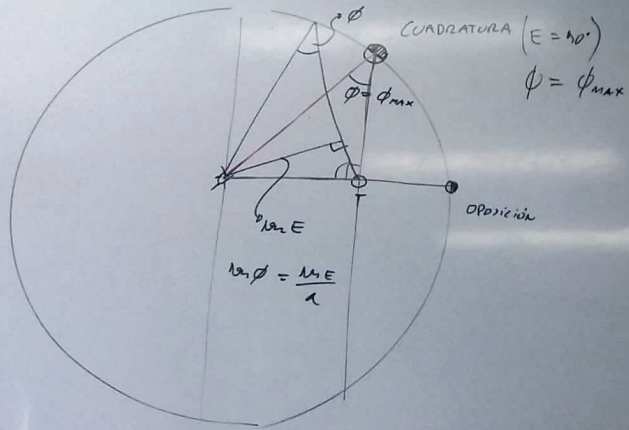


$$\frac{2\pi}{S} = \frac{k}{a^3} - \frac{k}{1}$$

↑  
VENUS

$$\frac{2\pi}{S} = \frac{k}{0.723^3} - k = k(0.6266) \Rightarrow \frac{1}{S} = 1.7 \times 10^{-3} \text{ día}^{-1} \Rightarrow S = 585 \text{ días}$$

MOVIMIENTO APARENTE PLANETARIO (órbitas circulares:  
 $\vec{r} = r_m \cdot \hat{r}, \vec{v} = a \cdot \hat{t}$ )



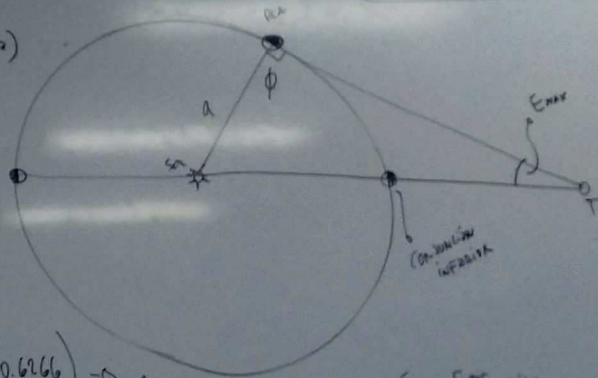
PALETA INFERIOR

VENUS:  $a = 0.723 \text{ UA}$

$$\sin E_{max} = \frac{a}{1}$$

$\Rightarrow E_{max} = \text{ARCSIN}(0.723)$   
 $46^\circ$

CONJ. SUP.

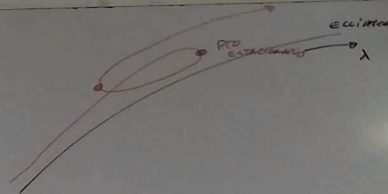
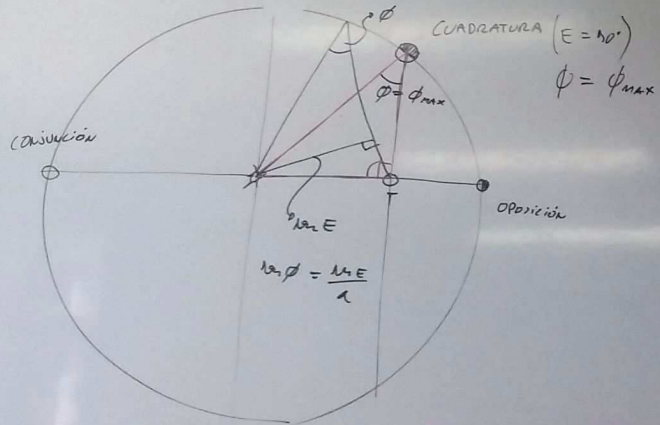


$$\frac{2\pi}{S} = \frac{k}{a^3} - \frac{k}{1}$$

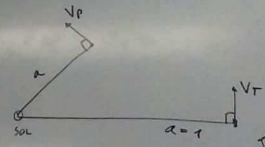
VENUS

$$\frac{2\pi}{S} = \frac{k}{0.723^3} - k = k(0.6266) \Rightarrow \frac{1}{S} = 1.7 \times 10^{-3} \text{ día}^{-1} \Rightarrow S \approx 585 \text{ días}$$

MOVIMIENTO APARENTE PLANETARIO (órbitas circulares:  $\vec{r} = 1 \text{ u. } \hat{r}, \vec{F} = a \cdot \hat{r}$ )



PUNTOS ESTACIONARIOS

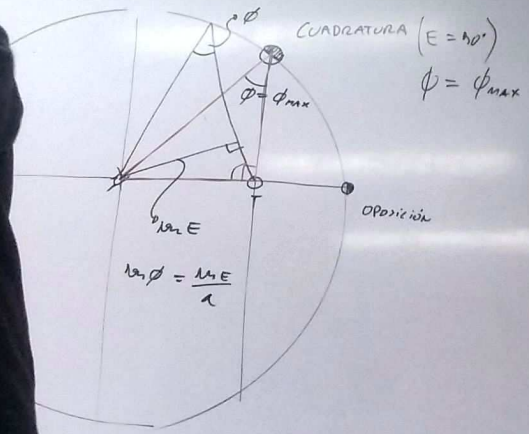


$V = a \cdot$





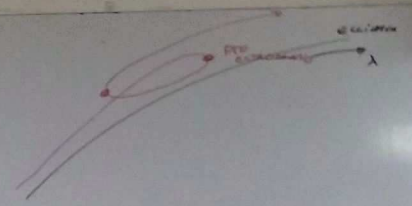
MOVIMIENTO APARENTE PLANETARIO (órbitas circulares:  
 $\vec{r} = a \cdot \hat{r}, \vec{v} = a \cdot \dot{\phi} \cdot \hat{\phi}$ )



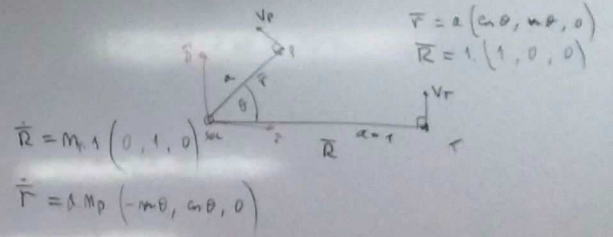
$$a_P \phi = \frac{a_E \phi_E}{1}$$

CUADRATURA ( $E = 90^\circ$ )  
 $\phi = \phi_{max}$

OPPOSICIÓN



PUNTOS ESTACIONARIOS  $\dot{\alpha} = 0$



$$\vec{r} = a \cdot \hat{r} = a \cdot (0, 1, 0)$$

$$\vec{v} = a \cdot \dot{\phi} \cdot \hat{\phi} = a \cdot \dot{\phi} \cdot (-\sin\theta, \cos\theta, 0)$$

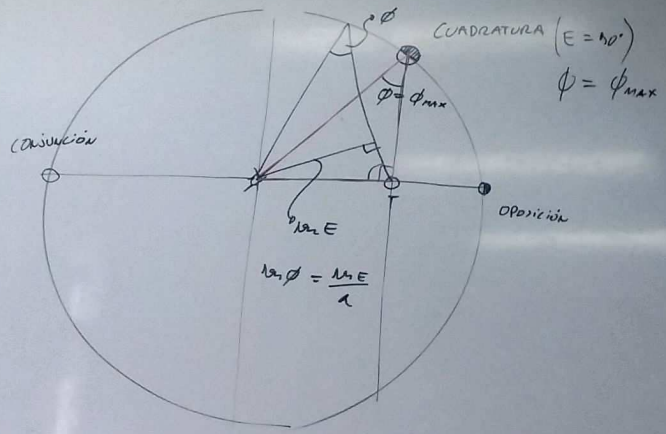
$$\vec{v} = a \cdot \dot{\phi} \cdot (-\sin\theta, \cos\theta, 0)$$

$$\vec{r} = a \cdot (1, 0, 0)$$

$$V = a \cdot \dot{\phi}$$

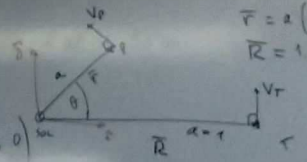


MOVIMIENTO APARENTE PLANETARIO (órbitas circulares:  
 $\vec{r} = \mu \cdot \hat{R}$ ,  $\vec{F} = a \cdot \hat{F}$ )



PUNTOS ESTACIONARIOS  $\dot{\zeta} = 0$

$\vec{F} = a(\cos\theta, \sin\theta, 0)$   
 $\vec{R} = r(1, 0, 0)$



$\vec{R} = \mu r (1, 0, 0)$

$\vec{F} = \mu M_p (-\cos\theta, \sin\theta, 0)$

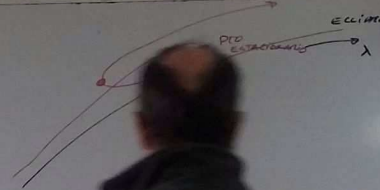
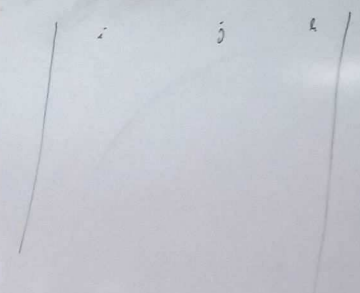
$V = a \cdot \omega$

$\vec{P} = \vec{F} - \vec{R}$

$\dot{\vec{P}} \cdot \hat{S} + \vec{P} \cdot \dot{\hat{S}} = \dot{\vec{F}} - \dot{\vec{R}}$

$\hat{S} \wedge \dot{\vec{P}} = \hat{S} \wedge (\dot{\vec{F}} - \dot{\vec{R}}) \Rightarrow 0$

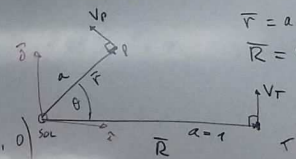
PUES PDS  
 $(\vec{F} - \vec{R}) \wedge (\dot{\vec{F}} - \dot{\vec{R}}) = 0$



PUNTOS ESTACIONARIOS  $\Rightarrow \dot{\hat{s}} = 0$

$$\vec{r} = a(\cos\theta, \sin\theta, 0)$$

$$\vec{R} = 1 \cdot (1, 0, 0)$$



$$\dot{\vec{R}} = m_{\oplus} \cdot (0, 1, 0)$$

$$= \Delta \cdot M_{\oplus} (-\sin\theta, \cos\theta, 0)$$

$$V = a \cdot \dot{M}$$

$$\vec{p} \cdot \hat{s}$$

$$\vec{p} = \vec{r}$$

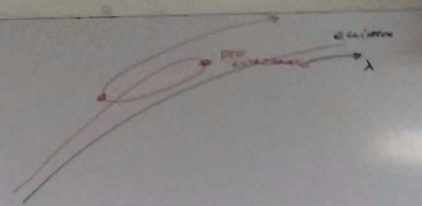
$$\ddot{\vec{s}} +$$

POSED PDS

$$(\vec{r} - \vec{R}) \wedge (\ddot{\vec{r}} - \ddot{\vec{R}}) = 0$$



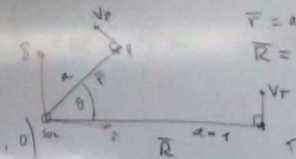
$$= \hat{k} \left[ (k \cos \theta - 1) \sqrt{2 M_T g \theta - M_T} + a M_T \sin^2 \theta \right] = 0$$



PUNTOS ESTACIONARIOS  $\dot{\hat{s}} = 0$

$$\vec{F} = a (\cos \theta, \sin \theta, 0)$$

$$\vec{R} = 1 (1, 0, 0)$$



$$\vec{R} = M_T 1 (0, 1, 0)$$

$$\vec{F} = a M_T (-\sin \theta, \cos \theta, 0)$$

$$V = a \cdot \dot{\theta}$$

$$\vec{P} = \vec{F} - \vec{R}$$

$$\dot{\hat{s}} + \hat{s} \times \dot{\hat{s}} = \vec{F} - \vec{R}$$

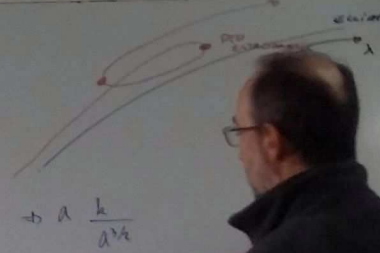
$$\hat{s} \wedge \dot{\hat{s}} = \hat{s} \wedge (\vec{F} - \vec{R}) \Rightarrow$$

$$\boxed{(\vec{F} - \vec{R}) \wedge (\vec{F} - \vec{R}) = 0}$$

$$\begin{bmatrix} kx - 1 & m_p g \\ -m_p \omega^2 x & m_p g - m_T \end{bmatrix} = \hat{k} \left[ (kx - 1)(m_p g - m_T) + m_p \omega^2 x \right] = 0$$

$$\rightarrow \underbrace{m_p \omega^2 x}_{\text{circled}} - \underbrace{m_p g m_T - m_p g + m_T}_{\downarrow} + \underbrace{m_p \omega^2 x}_{\text{circled}} = 0$$

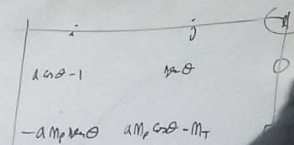
$$m_p - (m_T + m_p) a \cdot g \theta + m_T = 0$$



PUNTO ESTACIONARIO  $\dot{x} = 0$

$$m = \sqrt{\frac{k}{\omega^2}} = \frac{k}{\omega^2}$$

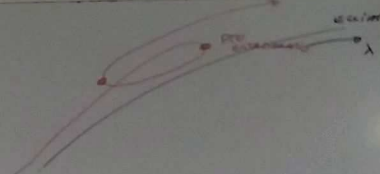
$$\rightarrow a \frac{k}{\omega^2}$$



$$-a M_p \cos \theta - M_r + a M_p \cos \theta + a M_p \sin^2 \theta = 0$$

$$\rightarrow a M_p \cos^2 \theta = 0$$

$$a M_p \sin^2 \theta = 0$$



PUNTOS ESTACIONARIOS  $\dot{\lambda} = 0$

$$m \sqrt{r^3/a^3} = \frac{h}{a^{3/2}}$$

$$\rightarrow a \frac{k}{a^{3/2}} - \left( \frac{k}{r^m} + \frac{k}{a^m} \right) a \cos \theta + \frac{h}{r^m} = 0$$

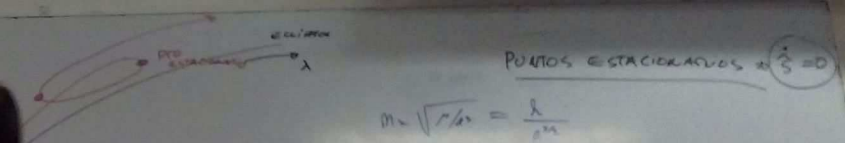
$$\Rightarrow a^{-1/2} - (1 + a^{-m}) \cos \theta + 1 = 0$$

$$\Rightarrow (a + a^{-1/2}) \cos \theta = 1 + a^{-1/2} \Rightarrow \cos \theta = \frac{1 + a^{-1/2}}{(a + a^{-1/2})}$$



$$\begin{array}{c}
 \begin{array}{|c|c|}
 \hline
 i & j \\
 \hline
 a \cos \theta - 1 & a \sin \theta \\
 -a m_p \sin \theta & a m_p \cos \theta - m_T \\
 \hline
 \end{array}
 \end{array}
 \begin{array}{c}
 \circledast \\
 \circ \\
 \circ
 \end{array}
 = \hat{k} \left[ (a \cos \theta - 1)(a m_p \cos \theta - m_T) + a^2 m_p \sin^2 \theta \right] = 0$$

$$\begin{aligned}
 \rightarrow \circledast m_p a \cos^2 \theta - a \cos \theta m_T - a m_p \sin \theta + m_T + \circledast a^2 m_p \sin^2 \theta &= 0 \\
 \downarrow \\
 \circledast m_p - (m_T + m_p) a \cos \theta + m_T &= 0
 \end{aligned}$$

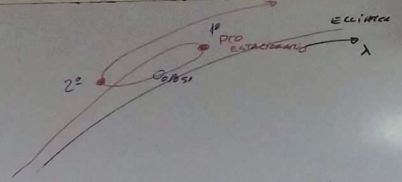
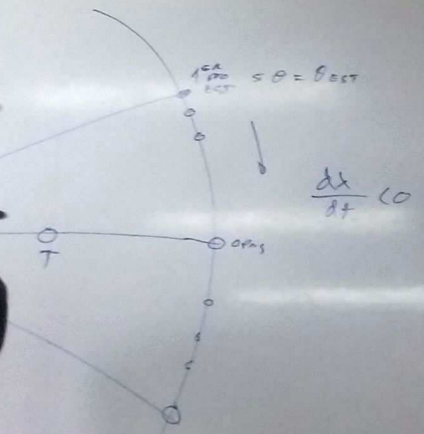


$$m = \sqrt{r/a} = \frac{a}{a^2}$$

$$-\left(\frac{a}{1^2} + \frac{a}{a^2}\right) a \cos \theta + \frac{a}{1^2} = 0$$

$$a^{-2/2} \cdot a \cos \theta + 1 = 0$$

$$\cos \theta = 1 + a^{1/2} \Rightarrow \cos \theta = \frac{1 + a^{1/2}}{(a + a^{-1/2})} > 0 \Rightarrow \theta < 90^\circ$$



PUNTOS ESTACIONARIOS  $\Rightarrow \dot{\xi} = 0$

$$h = \sqrt{l^2 a^3} = \frac{h}{a^{3/2}}$$

$$\Rightarrow a^2 \frac{h}{a^{3/2}} - \left( \frac{h}{1^3} + \frac{h}{a^3} \right) a \cos \theta + \frac{h}{1^3} = 0$$

$$\Rightarrow a^{+1/2} - \left( 1 + a^{-3} \right) \cdot a \cos \theta + 1 = 0$$

$$\Rightarrow \left( a + a^{-1/2} \right) \cdot \cos \theta = 1 + a^{+1/2} \Rightarrow \cos \theta_{EST} = \frac{1 + a^{+1/2}}{\left( a + a^{-1/2} \right)} > 0 \Rightarrow \theta < 90^\circ$$

$\theta = 2 \times 31^\circ = 76^\circ$   
 $60^\circ \rightarrow S$   
 $4^\circ \rightarrow \Delta t = 5.7c$

$\frac{dx}{dt} < 0$

**CERES  $a = 2.768 u_a$**

$\theta_{EST} = 37,75$

$\theta = \theta_{EST}$

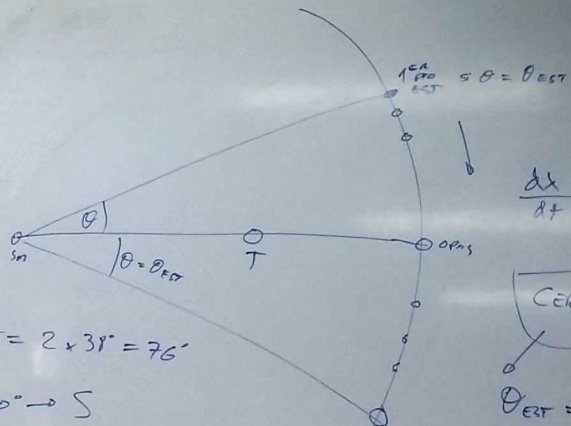
**PUNTOS ESTACIONARIOS  $\dot{\theta} = 0$**

$m = \sqrt{\frac{r}{a}} = \frac{h}{a^2 \dot{\theta}}$

$\rightarrow a^2 \frac{k}{a^{3/2}} - \left( \frac{k}{1^m} + \frac{k}{a^m} \right) a \cos \theta + \frac{k}{1^m} = 0$

$\Rightarrow a^{+1/2} - (1 + a^{-m}) \cdot a \cos \theta + 1 = 0$

$\Rightarrow (a + a^{-1/2}) \cdot \cos \theta = 1 + a^{1/2} \Rightarrow \cos \theta_{EST} = \frac{1 + a^{1/2}}{(a + a^{-1/2})} > 0 \Rightarrow \theta < 90^\circ$



$$\frac{dx}{dt} < 0$$

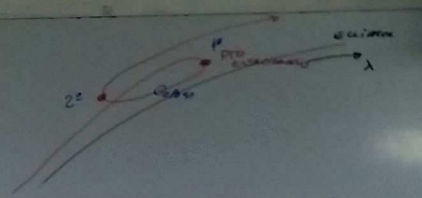
CERES  $a = 2.768 u$

$$\theta_{EST} = 37,75$$

$$\Delta\theta = 2 \times 31' = 76'$$

$$\Delta\theta = 360^\circ \rightarrow S$$

$$76' \rightarrow \Delta t = \frac{5.76}{360} = 18 \text{ días}$$



PUNTOS ESTACIONARIOS  $\dot{\theta} = 0$

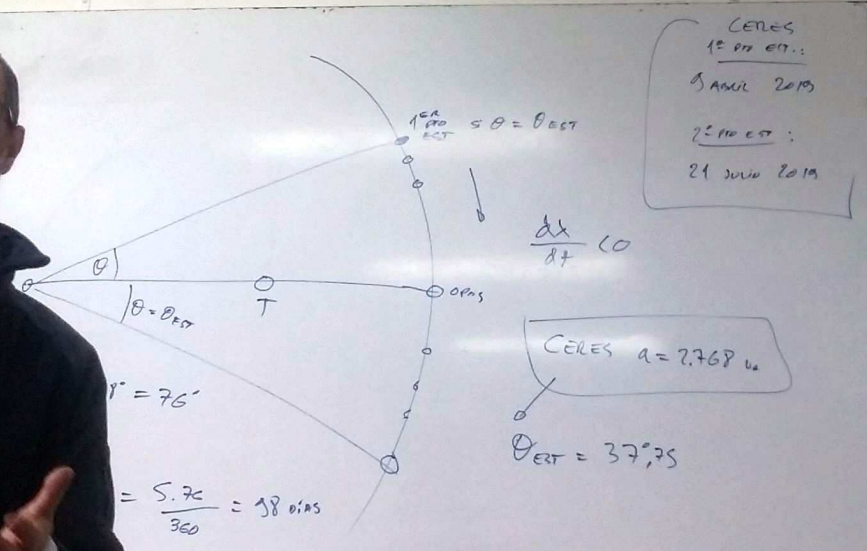
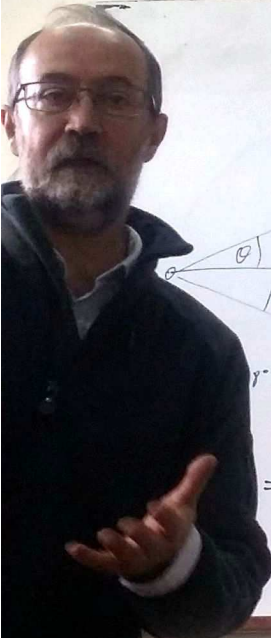
$$m = \sqrt{\frac{r}{a}} = \frac{h}{a^2}$$

$$\rightarrow a^2 \frac{k}{a^{3/2}} - \left( \frac{k}{1^3} + \frac{k}{a^3} \right) a \cos\theta + \frac{k}{1^3} = 0$$

$$\Rightarrow a^{+1/2} - (1 + a^{-4}) \cdot a \cos\theta + 1 = 0$$

$$\Rightarrow (a + a^{-1/2}) \cdot \cos\theta = 1 + a^{1/2} \Rightarrow \cos\theta_{EST} = \frac{1 + a^{1/2}}{(a + a^{-1/2})} > 0 \Rightarrow \theta < 90^\circ$$





CERES  
1er po EST:  
3 Abril 2019  
2o po EST:  
21 Julio 2019

PUNTOS ESTACIONARIOS  $\dot{r} = 0$

$m = \sqrt{\frac{r}{a}} = \frac{h}{a^{3/2}}$

$$\rightarrow a^2 \frac{h}{a^{3/2}} - \left( \frac{h}{1^m} + \frac{h}{a^m} \right) a \cos \theta + \frac{h}{1^m} = 0$$

$$\Rightarrow a^{+1/2} - \left( 1 + a^{-m} \right) a \cos \theta + 1 = 0$$

$$\Rightarrow \left( a + a^{-1/2} \right) \cos \theta = 1 + a^{1/2} \Rightarrow \cos \theta_{EST} = \frac{1 + a^{1/2}}{\left( a + a^{-1/2} \right)} > 0 \Rightarrow \theta < 90^\circ$$