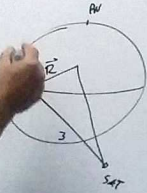


①

$$\phi = 0$$

$\tau < 1$



//

—

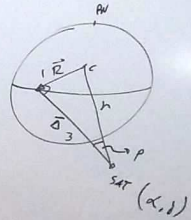


①

$\phi = 0$

$TSL = 6^h$

$\alpha = 0^h$



$$r^2 = (1R)^2 + (3R)^2 = 10R^2$$

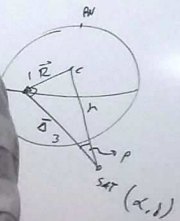
$$\vec{R} = \text{Pos. OBS} = \begin{pmatrix} \cos \phi \cos TSL \\ \cos \phi \sin TSL \\ \sin \phi \end{pmatrix} \begin{matrix} 1R \\ 3R \\ 0 \end{matrix}$$

$$\vec{\delta} = \begin{pmatrix} \cos \delta \cdot \cos \alpha \\ \cos \delta \cdot \sin \alpha \\ \sin \delta \end{pmatrix} 3R$$

$$\vec{F} = \vec{R} + \vec{\delta}$$

$$\vec{F} = (3 \cdot \cos 30, 1, 3 \cdot \sin 30) = r (\cos \alpha \cos \delta, \sin \alpha \cos \delta, \sin \delta)$$

(1)



$$r^2 = (1R)^2 + (3R)^2 = 10R^2$$

$$\vec{R} = \text{pos. obs} = \begin{pmatrix} \cos \delta \cos TSC \\ \cos \delta \sin TSC \\ \sin \delta \end{pmatrix} R$$

$$\vec{\delta} = \begin{pmatrix} \cos \delta \cdot \cos \alpha \\ \cos \delta \cdot \sin \alpha \\ \sin \delta \end{pmatrix} 3R$$

$$\vec{F} = \vec{R} + \vec{\delta}$$

$$\vec{F} = (3 \cdot \cos 30^\circ, 1, 3 \cdot \cos 30^\circ) = r \begin{pmatrix} \cos \alpha \cos \delta \\ \cos \alpha \sin \delta \\ \sin \delta \end{pmatrix}$$

$-90^\circ < \delta < +90^\circ$

$$\sin \alpha \cos \delta = \frac{1}{r \cdot \cos \delta} = 0.35$$

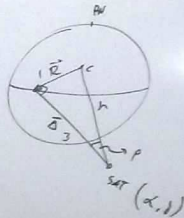


(1)

$\phi = 0$

$TSL = 6^h$

$\alpha = 0^h$



$r^2 = (1R)^2 + (3R)^2 = 10R^2$

$\vec{R} = \text{pos. OBS} = \begin{pmatrix} \cos \delta \cos TSL \\ \cos \delta \sin TSL \\ \sin \delta \end{pmatrix} R$

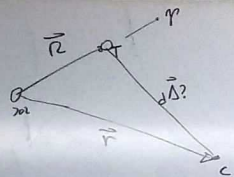
$\vec{\Delta} = \begin{pmatrix} \cos \delta \cos \alpha \\ \cos \delta \sin \alpha \\ \sin \delta \end{pmatrix} 3R$

$\vec{F} = \vec{R} + \vec{\Delta}$

$\vec{F} = (3 \cos 30, 1, 3 \sin 30) = r \begin{pmatrix} \cos \delta \cos \alpha \\ \cos \delta \sin \alpha \\ \sin \delta \end{pmatrix}$

$-90 < \delta < +90$

$\sin \delta = \frac{1}{r \cos \delta} = 0.35$



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

$\vec{r} = \text{Sun} (\cos \beta \cos \lambda, \cos \beta \sin \lambda, \sin \beta)$

$\vec{\Delta} = \vec{r} - \vec{R}$

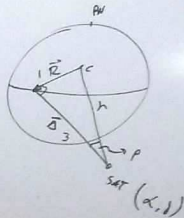


(1)

$\phi = 0$

$TSL = 6^h$

$\alpha = 0^h$



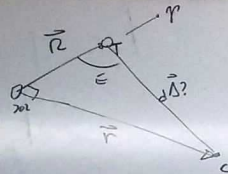
$r^2 = (1R)^2 + (3R)^2 = 10R^2$

$\vec{R} = \text{pos. obs} = \begin{pmatrix} \cos \delta \cos \alpha \\ \cos \delta \sin \alpha \\ \sin \delta \end{pmatrix} R$

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

$\vec{F} = (3, \cos 30^\circ, 1, 3)$

(2)



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

$\vec{F} = S_{\text{un}} (\cos \beta \cos \lambda, \cos \beta \sin \lambda, \sin \beta)$

$\vec{F} = S (0, \cos \beta, \sin \beta)$

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

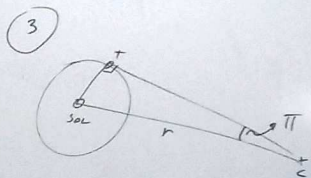
$|\Delta| = \sqrt{26}$

$E = 78.7$

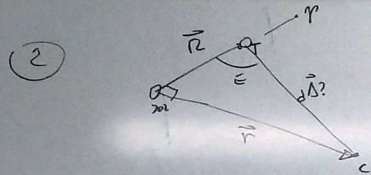
$\rightarrow \delta < +90$

$\sin \alpha_6 = \frac{1}{r \cdot \cos \delta_6} = 0.35$





$$\sin \alpha = \frac{r_{\text{Sun}}}{r_{\text{Earth}}} = \frac{1}{20,000}$$



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

$$\vec{r} = S_{\text{un}} (\cos \beta \cos \alpha, \cos \beta \sin \alpha, \sin \beta)$$

$$\vec{F} = S (0, \cos \beta, \sin \beta)$$

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

$$|\Delta| = \sqrt{26}$$

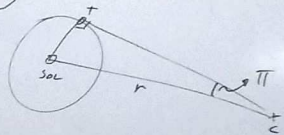
$$E = 78,7$$

$-90 < \delta < +90$

$$\sin \alpha = \frac{1}{r \cdot \cos \beta} = 0,35$$



3

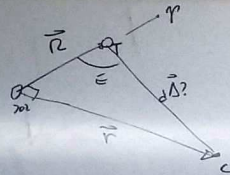


$$\sin \alpha = \frac{R}{r} = \frac{1}{20.000}$$

$$\alpha \text{ (arcos)} = 5 \times 10^{-4} \times \frac{360}{2\pi \times 10^5} \times 60 \times 60 = 10,3'' = \alpha$$

$$k = 20''$$

2



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

$$\vec{F} = S_{un} (\cos \beta \cos \lambda, \cos \beta \sin \lambda, \sin \beta)$$

$$\vec{F} = S (0, \cos \beta, \sin \beta)$$

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

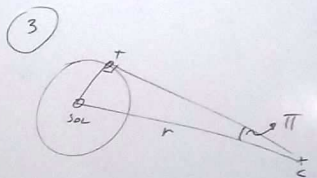
$$|\Delta| = \sqrt{26}$$

$$E = 78,7$$

$-90 < \delta < +90$

$$\sin \alpha_6 = \frac{1}{r \cdot \cos \delta} = 0,35$$





$$\sin \pi = \frac{1 \text{ ua}}{r_{\text{ua}}} = \frac{1}{20.000}$$

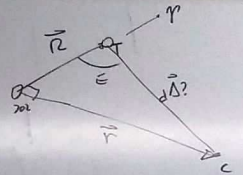
$$\pi (\text{rads}) = 5 \times 10^{-4} \times \frac{360}{2\pi \times 1000000}$$

$$x = \pi \cdot \sin(\lambda_0 - \lambda) - K \cos(\lambda_0 - \lambda)$$

$$y = -\pi \sin \beta \cdot \cos(\lambda_0 - \lambda) - K \sin \beta \cdot \sin(\lambda_0 - \lambda)$$

λ_0

(2)



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

$$\vec{F} = S_{\text{un}} (\cos \beta \cos \lambda, \cos \beta \sin \lambda, \sin \beta)$$

$$\vec{F} = S (0, \cos \beta, \sin \beta)$$

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

$$|\Delta| = \sqrt{26}$$

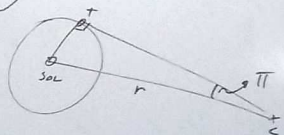
$$E = 78.7$$

$-90 < \delta < +90$

$$\sin \alpha_6 = \frac{1}{r \cdot \cos \delta_6} = 0.35$$



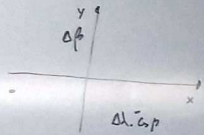
3



$$\sin \pi = \frac{1 \text{ ua}}{r_{\text{ua}}} = \frac{1}{20.000}$$

$$\pi (\text{Rads}) = 5 \times 10^{-4} \times \frac{360}{2\pi \cdot 101592} \times 60 \cdot 60 = 10''.3 = \pi$$

$$k = 20''$$

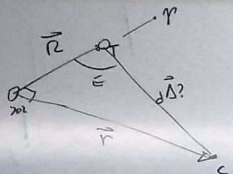


$$x = \pi \cdot \sin(\lambda_0 - \lambda) - k \cos(\lambda_0 - \lambda)$$

$$y = -\pi \sin \beta \cdot \cos(\lambda_0 - \lambda) - k \sin \beta \cdot \sin(\lambda_0 - \lambda)$$

$$\lambda_0 = \lambda$$

2



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

$$\vec{F} = S_{\text{un}} (\cos \beta \cos \lambda, \cos \beta \sin \lambda, \sin \beta)$$

$$\vec{F} = S (0, \cos \beta, \sin \beta)$$

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

$$|\Delta| = \sqrt{26}$$

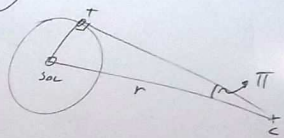
$$E = 78.7$$

$-90 < \delta < +90$

$$\mu \alpha_6 = \frac{1}{r \cdot \cos \delta} = 0.35$$



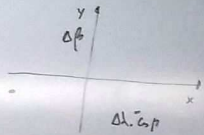
3



$$\mu_{\pi} = \frac{v_{\pi}}{r_{\pi}} = \frac{1}{20.000}$$

$$\mu_{\pi} (\text{mas}) = 5 \times 10^{-4} \times \frac{360}{2 \times 3.14159} \times 60 \times 60 = 10,3 = \mu_{\pi}$$

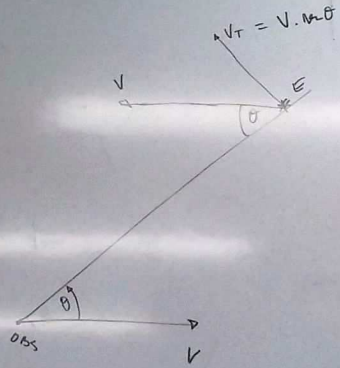
$$k = 20''$$



$$x = \pi \cdot \sin(\lambda_0 - \lambda) - k \cos(\lambda_0 - \lambda)$$

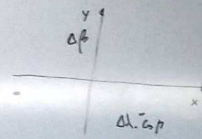
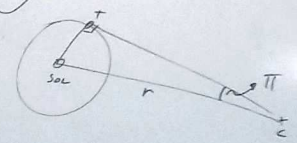
$$y = -\pi \cdot \sin \beta \cdot \cos(\lambda_0 - \lambda) - k \sin \beta \cdot \sin(\lambda_0 - \lambda)$$

$$\lambda_0 = \lambda$$



$$\Delta \theta = \frac{V}{c} \cdot \mu_{\theta}$$

3



$$x = \pi \cdot \sin(\lambda_0 - \lambda) - K \cos(\lambda_0 - \lambda)$$

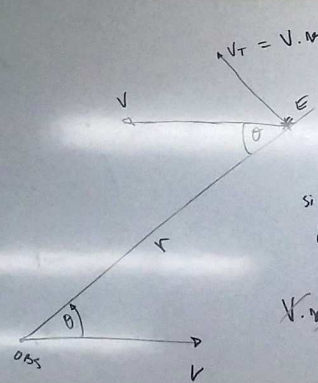
$$y = -\pi \cdot \sin \beta \cdot \cos(\lambda_0 - \lambda) - K \sin \beta \cdot \sin(\lambda_0 - \lambda)$$

$$\lambda_0 = \lambda$$

$$\sin \pi = \frac{1 \text{ ua}}{r_{\text{ua}}} = \frac{1}{20.000}$$

$$\pi (2005) = 5 \times 10^{-4} \times \frac{360}{2\pi \cdot 1000000} \times 60 \cdot 60 = 10.3 = \pi$$

$$K = 20.5$$



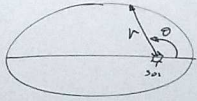
$$\Delta \theta = \frac{v}{c} \cdot \sin \theta$$

$$\sin \Delta t = 1 \text{ a} \approx 0$$

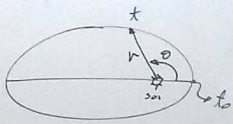
$$d\theta = \frac{v}{c} \cdot \sin \theta$$

$$v \cdot \sin \theta = r \cdot \frac{d\theta}{dt} = \frac{1}{\Delta t}$$

$$v = c \cdot \Delta t \cdot 1 \text{ a} \approx 0$$



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

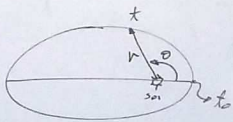


$$r = \frac{a(1-e^2)}{1+e \cos \theta}$$

$\theta(t)?$

$$\theta(t) \cong M + 2e \cos M + \frac{5}{4} e^2 \cos 2M \dots$$

$$M = \underbrace{m}_{\text{circled}} (t - t_0)$$



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

$\theta(t)?$

$$\theta(t) \cong M + 2e \cos M + \frac{5}{4} e^2 \cos 2M \dots$$

$$M = \underbrace{m}_{\sqrt{\mu/a^3}} (t - t_0)$$

DEFINIE TAL RUF

$$r = a(1 - e \cos E)$$

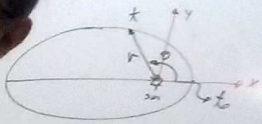
$$M = E - e \cos E$$

EL. KOSON

RES. UNIVÉLIA EL. KOSON

$$E = M + e \cos E$$





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

$$\approx M + 2e \cos \theta + \frac{5}{4} e^2 \cos^2 \theta \dots$$

$$= \frac{m}{\sqrt{1/a^3}} (t - t_0)$$

DEFINIE TAL RUS

$$r = a(1 - e \cos E)$$

$$M = E - e \cos E$$

ER. KOSOL

RES. UNIVERZITAT EI. KOSOL

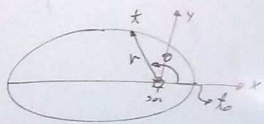
$$(r, \theta) \Rightarrow F = (r \cos \theta, r \sin \theta, 0)$$

$$E = M + e \cos E$$

$E_0 = n$

$$E_1 = M + e \cos(E_0)$$

$$E_2 = M + e \cos(E_1)$$



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

$\theta(t)$?

$$\theta(t) \cong M + 2e \cos n + \frac{5}{4} e^2 \cos 2M \dots$$

$$M = \underbrace{m}_{\sqrt{1/a^3}} (t - t_0)$$

DEFINIE TAL RUS

$$r = a(1 - e \cos E)$$

$$M = E - e \cos E$$

ET. KOSON

RES. UNENITA ET. KOSON

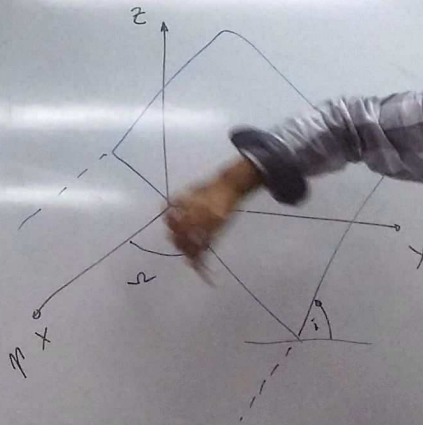
$$E = M + e \cos E \quad E_0 = n$$

$$E_1 = M + e \cos(E_0) \rightarrow n$$

$$E_2 = M + e \cos(E_1)$$

$$(r, \theta) \Rightarrow F = (r \cos \theta, r \sin \theta, 0)$$

PLANO ORBITAL (Ω, i)



a = SEMI EJE ORBITAL
 e = EXCENTRICIDAD
 t_0 = PASAJE POR AFELIO

DEFINEE TAL QUE

$$r = a(1 - e \cos E)$$

$$M = E - e \sin E$$

EL KEPLER

RES. NUMERICA EL KEPLER

$$E = M + e \sin E \quad E_0 = M$$

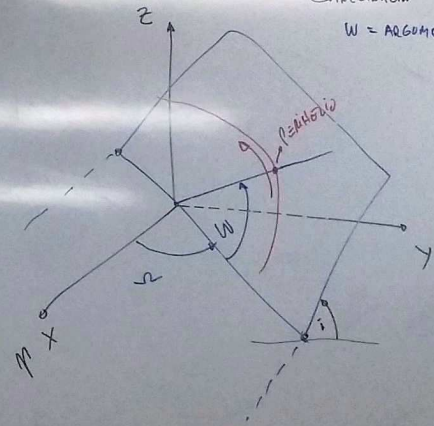
$$E_1 = M + e \sin(E_0) \rightarrow n$$

$$E_2 = M + e \sin(E_1)$$

$$(r, \theta) \Rightarrow F = (r \cos \theta, r \sin \theta, 0)$$

PLANO ORBITAL (Ω, i)
 LONGITUD UNO ASCENDENTE
 INCLINACION

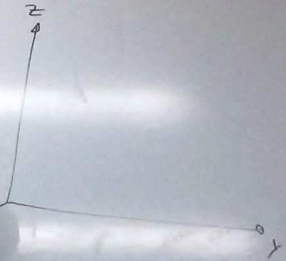
W = ARGUMENTO DEL PERHELIO



$(x, y) \equiv$ PLANO ECLIPTICO

a = SEMI-MAIOR
 e = EXCENTRICIDADE
 t_0 = PERÍODO
 i = INCLINAÇÃO
 Ω = LONGITUDE DO NÓ ASCENDENTE
 w = ARGUMENTO DO PERÍHELIO

$\eta = x$



Res. UNIVERSAL DE KEPLER

$$E = M + e \cdot \cos E$$

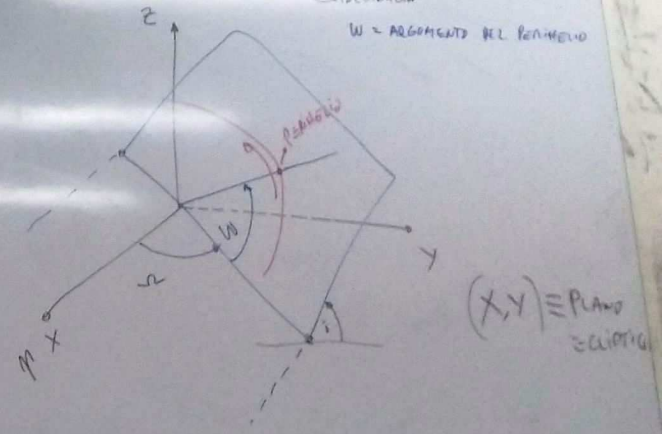
$$E_1 = M + e \cdot \cos E_0 \rightarrow M$$

$$E_2 = M + e \cdot \cos E_1$$

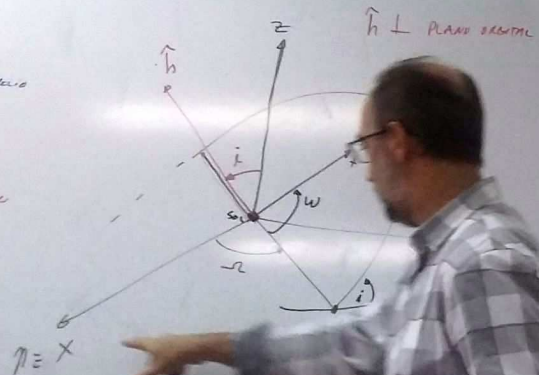
$$(r, \theta) \rightarrow F = (r \cos \theta, r \sin \theta, 0)$$

PLANO ORBITAL

LONGITUDE DO NÓ ASCENDENTE
 INCLINAÇÃO
 w = ARGUMENTO DO PERÍHELIO



- a = SEMI-EJE ORBITAL
- e = EXCENTRICIDAD
- t_0 = PASAJE POR AFELIO
- i = INCLINACIÓN
- Ω = LONG. LINDA ASC
- w = ARG. DEL PERHELIO



RES. UNIFORME EC. KEPLER

$$E = M + e \cdot \cos E$$

$E_0 = M$

$$E_1 = M + e \cdot \cos(E_0) \rightarrow M$$

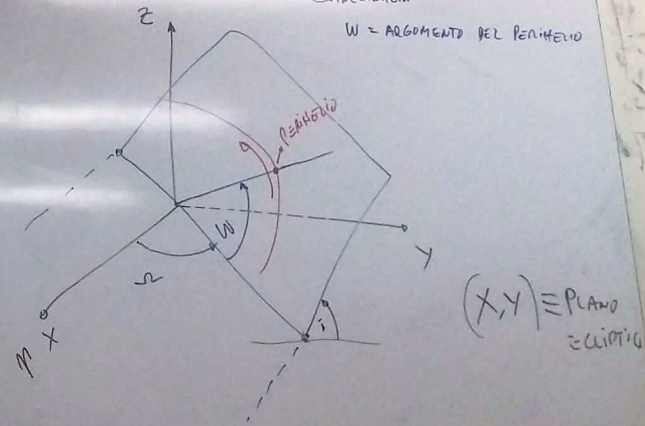
$$E_2 = M + e \cdot \cos(E_1)$$

$(r, \theta) \Rightarrow F = (r \cdot \cos \theta, r \cdot \sin \theta, 0)$ PLANO ORBITAL

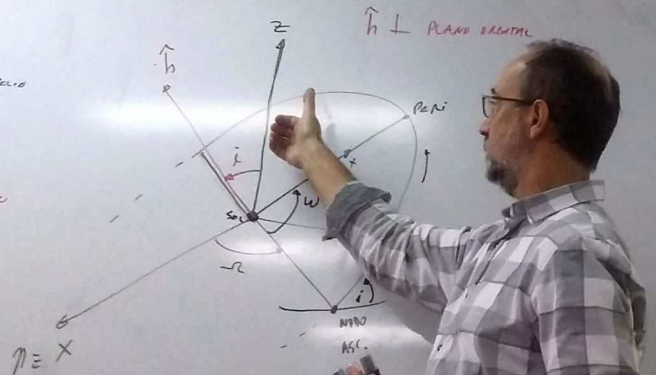
LONGITUD UNO ASCENDENTE

INCLINACION

w = ARGUMENTO DEL PERHELIO



- a = SEMI-EJE ORBITAL
- e = EXCENTRICIDAD
- t_0 = PASAJE POR AFELIO
- i = INCLINACIÓN
- Ω = LONG. LONG. ASC.
- w = ARG. DEL PERIFELIO



$$R_x(i) \cdot R_z(-w) \cdot \begin{pmatrix} x \\ y \\ 0 \end{pmatrix}$$

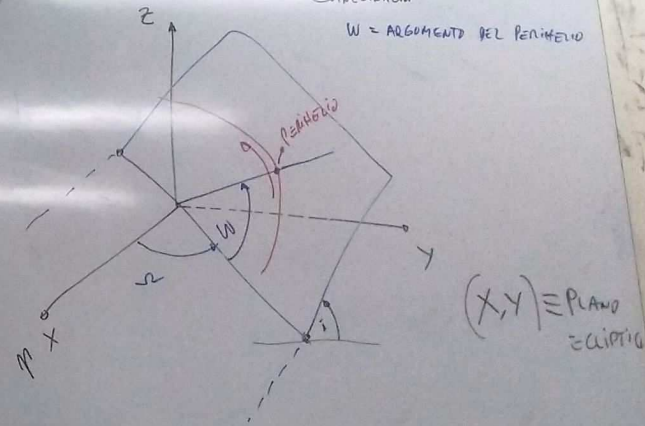
$$(r, 0) \Rightarrow \vec{F} = (r \cdot \cos \theta, r \cdot \sin \theta, 0) \quad \text{PLANO ORBITAL}$$

PLANO ORBITAL (Ω, i)

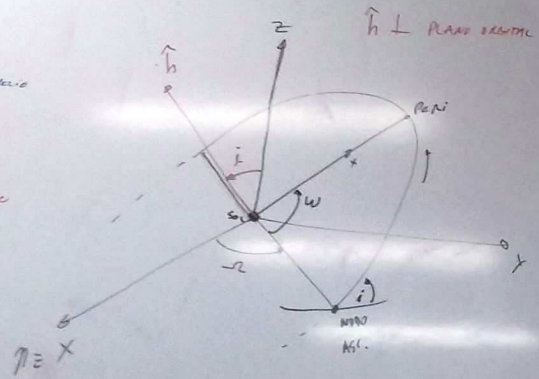
LONGITUD NUDO ASCENDENTE

INCLINACION

w = ARGUMENTO DEL PERIFELIO



- a = SEMI-EJE ORBITAL
- e = EXCENTRICIDAD
- t_0 = PASAJE POR AFELIO
- i = INCLINACIÓN
- Ω = LONG. LONG. ASC.
- ω = ARG. DEL PERHELIO

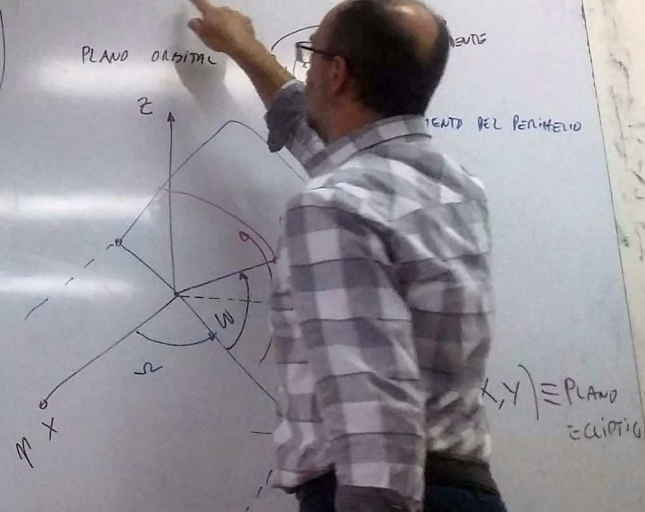


ECLIPSIAS RECTANGULARES

$$(x, y, z) = R_z(-\Omega) \cdot R_x(i) \cdot R_z(-\omega) \cdot \begin{pmatrix} x \\ y \\ 0 \end{pmatrix}$$

(α, β)

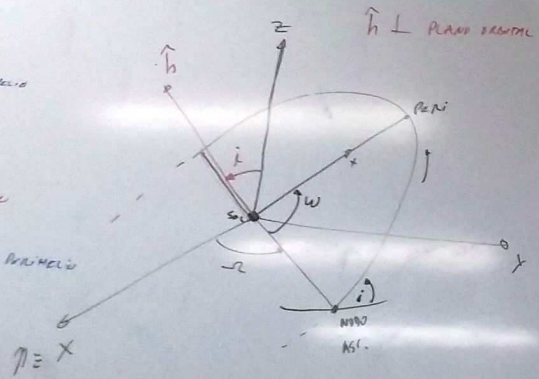
$(r, \theta) \Rightarrow F = (r \cdot \cos \theta, r \cdot \sin \theta, 0)$ PLANO ORBITAL



- a = SEMI-EJE ORBITAL
- e = EXCENTRICIDAD
- t_0 = PASAJE POR AFELIO
- i = INCLINACIÓN
- Ω = LONG. LONG. ASC.
- w = ARG. DEL PERIFELIO

$D = \Omega + w = \text{LONG. DEL PERIFELIO}$

$\lambda = D + M$
"LONG. MEDIA"



ECLIPSIAS RECTANGULARES

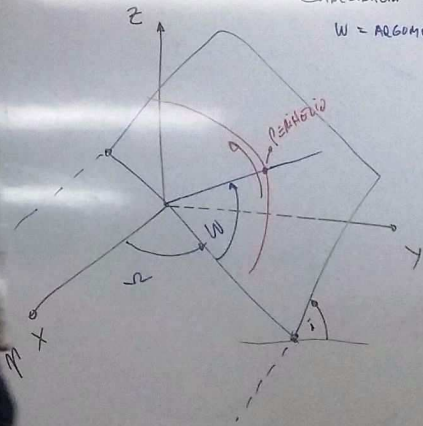
$(x, y, z) = R_z(-\Omega) R_x(i) R_w(w) \cdot \begin{pmatrix} x \\ y \\ 0 \end{pmatrix}$

(λ, β)

$\cos(\Omega + w) \rightarrow w$

$(r, \theta) \Rightarrow F = (r \cos \theta, r \sin \theta, 0)$ PLANO ORBITAL

LONGITUD UNO ASCENDENTE
INCLINACIÓN
 $w = \text{ARGUMENTO DEL PERIFELIO}$

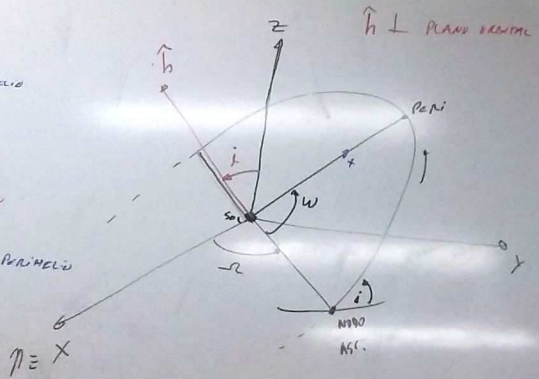


$(x, y) \in \text{PLANO ECLIPSIOS}$

- a = SEMI-EJE ORBITAL
- e = EXCENTRICIDAD
- t_0 = PASAJE POR AFELIO
- i = INCLINACIÓN
- Ω = LONG. LONG. ASC.
- w = ARG. DEL PERHELIO

$\mathcal{W} = \Omega + w = \text{LONG. DEL PERHELIO}$

$\lambda = \mathcal{W} + M$
"LONG. MED. S"



ECLIPSIAS RECTANGULARES

$$(X, Y, Z) = R_z(-\Omega) R_x(i) R_z(-w) \begin{pmatrix} x \\ y \\ 0 \end{pmatrix}$$

(λ, β)

$\cos(\Omega + w)$

\mathcal{W} = LONGITUD PERHELIO

EFEMÉRIDES

COMETA

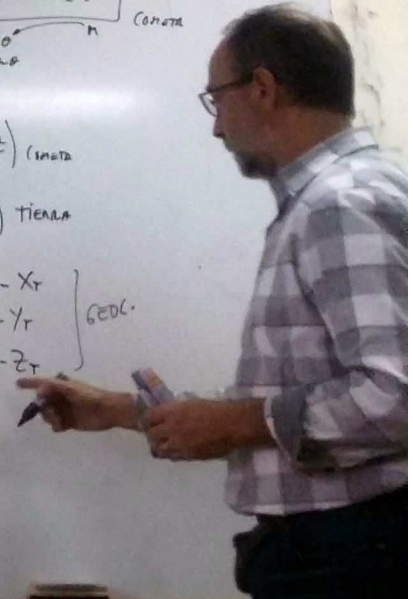
$$\begin{cases} x = r \cos \theta \\ y = r \sin \theta \\ z = 0 \end{cases}$$

(X, Y, Z) COMETA

(X, Y, Z) TIERRA

GEOC.

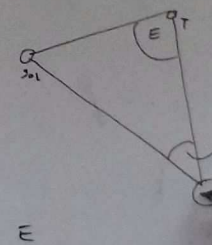
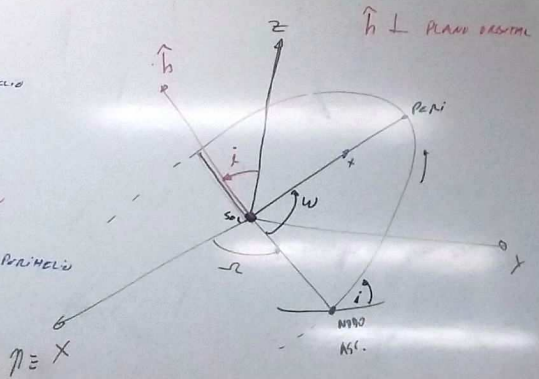
$$\begin{cases} X_G = X_C - X_T \\ Y_G = Y_C - Y_T \\ Z_G = Z_C - Z_T \end{cases}$$



- a = SEMI-EJE ORBITAL
- e = EXCENTRICIDAD
- f_0 = PASAJE POR AFELIO
- i = INCLINACIÓN
- Ω = LONG. LONG. ASC.
- W = ARG. DEL PERHELIO

$\bar{w} = \Omega + W = \text{LONG. DEL PERHELIO}$

$\lambda = \bar{w} + M$
"LONG. MED.ª"



EFEMÉRIDES

$x = r \cdot \cos \theta$
 $y = r \cdot \sin \theta$
 $z = 0$

(X, Y, Z) COMETA

(X, Y, Z) TIERRA

$\delta = X_c - X_T$
 $\gamma = Y_c - Y_T$
 $\beta = Z_c - Z_T$

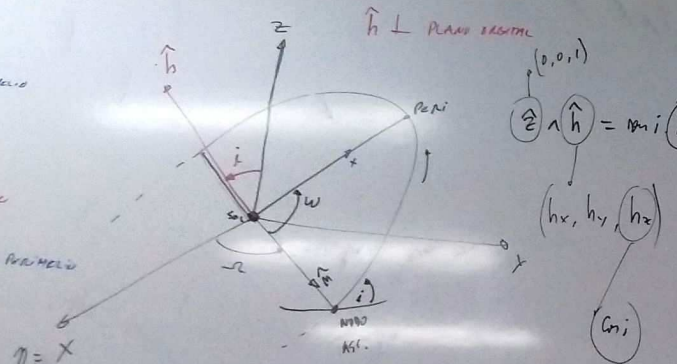
GEOC. $\Rightarrow \lambda_\delta, \beta_\delta$

$i \left(\lambda_\delta, \beta_\delta \right)$

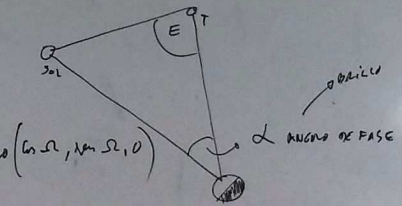
- a = SEMI-EJE ORBITAL
- e = EXCENTRICIDAD
- t_0 = PASAJE POR AFELIO
- i = INCLINACIÓN
- Ω = LONG. LONG. ASC.
- w = ARG. DEL PERHELIO

$D = -\Omega + w = \text{LONG. DEL PERHELIO}$

$\lambda = D + M$
"LONG. MEDIA"



$\hat{h} = (0, 0, 1)$
 $\hat{h} = \sin i \hat{h}_i$
 (h_x, h_y, h_z)
 (Ω, i)



$\Rightarrow h(\Omega, i)$

EFEMERIDES

$x = r \cos \theta$
 $y = r \sin \theta$
 $z = 0$

(X, Y, Z) COMETA

(X, Y, Z) TIERRA

$X_G = X_C - X_T$
 $Y_G = Y_C - Y_T$
 $Z_G = Z_C - Z_T$

GEOL. $\Rightarrow \lambda_G, \beta_G$

$i(\alpha_G, \delta_G)$