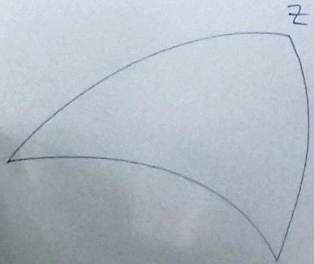
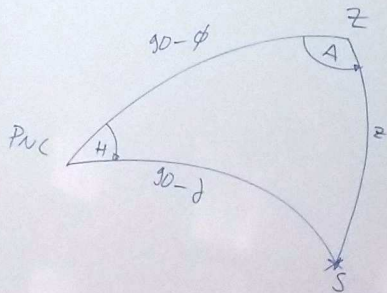


COORDENADAS ECUATORIALES TERRESTRES (GEOGRAFICAS) (λ, ϕ)
" " CELESTES (α, δ)
" HORIZONTALES (A, a)



[COORDENADAS ECUATORIALES TERRESTRES (GEOGRAFICAS) (λ, ϕ)
 " " CELESTES (α, δ)
 " HORIZONTALES (A, a)]



[DADO t y ESTRELLA (α, δ)
 OBSERVANDO (A, a)
 HALLAR (λ, ϕ)]

$$TSL = \alpha + H$$

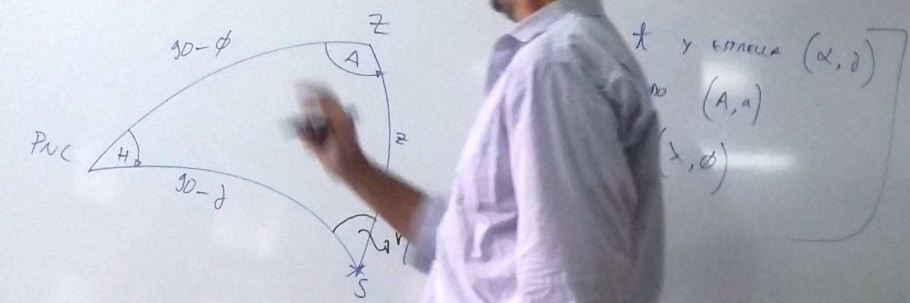
$$TSL = \alpha_T + H_T$$

F. SERVO:

$$\frac{y-A}{d} = \frac{y-H}{d}$$



COORDENADAS ECUATORIALES TERRESTRES (GEOGRAFICAS) (λ, ϕ)
 " " CELSIAS (α, δ)
 " HORIZONTALES (A, a)



$$TSL = \alpha + H$$

$$TSL = \alpha_p + H_p$$

F. seno:

$$\frac{\sin A}{\sin \delta} = \frac{\sin H}{\sin \phi}$$

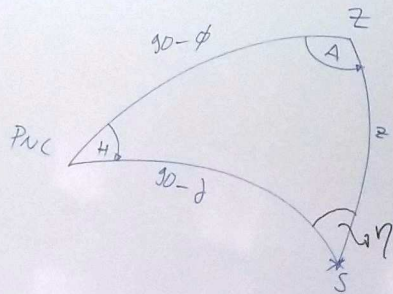
F. coseno:

$$\sin \phi = \sin \delta \cdot \cos z + \cos \delta \cdot \sin z \cdot \cos \psi$$

$$\cos z = \sin \delta \cdot \sin \phi + \cos \delta \cdot \cos \phi \cdot \cos H$$

$$\sin \delta =$$

[COORDENADAS ECUATORIALES TERRESTRES (GEOGRÁFICAS) (λ, ϕ)
 " " CELESTES (α, δ)
 " " HORIZONTALES (A, a)



[DADO t y estrella (α, δ)
 OBSERVANDO (A, a)
 HALLAR (λ, ϕ)

$$TSL = \alpha + H$$

$$TSL = \alpha_T + H_T$$

F. SERO:

$$\frac{\sin A}{\sin \delta} = \frac{\sin H}{\sin z} = \frac{\sin \eta}{\sin \phi}$$

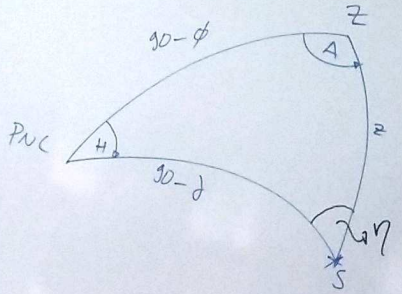
$$= \sin \delta \cdot \cos z + \cos \delta \cdot \sin z \cdot \cos \eta$$

$$= \sin \delta \cdot \sin \phi + \cos \delta \cdot \cos \phi \cdot \cos H$$

$$\cos z \cdot \sin \phi + \sin z \cdot \cos \phi \cdot \cos A$$

$$\cos \phi = \pm \sqrt{1 - \sin^2 \delta}$$

COORDENADAS ECUATORIALES TERRESTRES (GEOGRAFICAS) (λ, ϕ)
 " " CELESTES (α, δ)
 " HORIZONTALES (A, a)



DADO t y estrella (α, δ)
 OBSERVANDO (A, a)
 HALLAR (λ, ϕ)

$TSL = \alpha + H$
 $TSL = \alpha_T + H_T$

F. seno: $\frac{\sin A}{\sin \delta} = \frac{\sin H}{\sin \phi} = \frac{\sin \eta}{\sin \phi}$

F. coseno:

$$\cos \phi = \sin \delta \cdot \cos z + \cos \delta \cdot \sin z \cdot \cos \eta$$

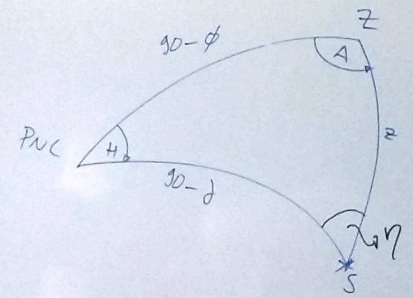
$$\cos z = \sin \delta \cdot \sin \phi + \cos \delta \cdot \cos \phi \cdot \cos H$$

$$\sin \delta = \cos z \cdot \sin \phi + \sin z \cdot \cos \phi \cdot \cos A$$

$\rightarrow X, Y \Rightarrow \phi$

$\cos \phi = +\sqrt{1 - \sin^2 \phi}$

[COORDENADAS ECUATORIALES TERRESTRES (GEOGRÁFICAS) (λ, ϕ)
 " " CELESTES (α, δ)
 " " HORIZONTALES (A, a)



[DADO t y estrella (α, δ)
 OBSERVANDO (A, a)
 HALLAR (λ, ϕ)

$TSL = \lambda + H$
 $TSL = \lambda_T + H_T$

$TSL = TSG + \lambda$

OBSERVADO t
 $\rightarrow X, Y \Rightarrow \phi$

F. seno: $\frac{\sin A}{\sin \delta} = \frac{\sin H}{\sin \phi} = \frac{\sin \eta}{\sin \phi}$

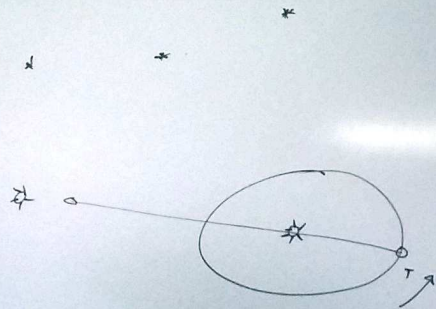
F. coseno:

$\cos \phi = \sin \delta \cdot \cos z + \cos \delta \cdot \sin z \cdot \cos \eta$

$\cos z = \sin \delta \cdot \sin \phi + \cos \delta \cdot \cos \phi \cdot \cos H$

$\sin \delta = \cos z \cdot \sin \phi + \sin z \cdot \cos \phi \cdot \cos A$

$\cos \phi = + \sqrt{1 - \sin^2 \phi}$



Estimular Púas

F. SERO:

$$\frac{\sin A}{\sin \delta} = \frac{\sin H}{\sin \phi} = \frac{\sin \eta}{\sin \phi}$$

F. COSO:

$$\sin \phi = \sin \delta \cdot \cos \alpha + \cos \delta \cdot \sin \alpha \cdot \cos \eta$$

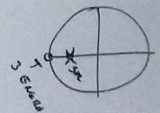
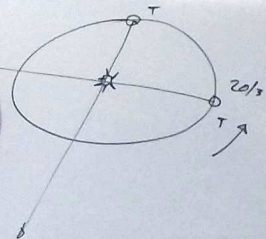
$$\cos \alpha = \frac{\sin \phi - \sin \delta \cdot \cos \alpha}{\cos \delta \cdot \cos \phi} \cdot \cos \eta$$

$$\sin \alpha = \frac{\cos \delta \cdot \sin \phi - \sin \delta \cdot \cos \phi \cdot \cos \eta}{\cos \delta \cdot \cos \phi}$$

APP
SISTEMA
LOCAL

$\alpha, \eta \Rightarrow \phi$

$$\cos \phi = \sqrt{1 - \sin^2 \phi}$$



F. seno:

$$\frac{\sin A}{\sin a} = \frac{\sin H}{\sin z} = \frac{\sin \varphi}{\sin \phi}$$

F. coseno:

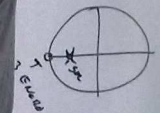
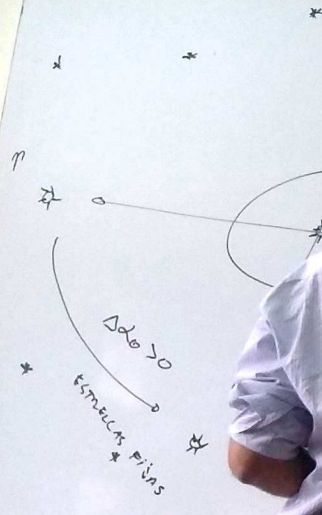
$$\begin{aligned} \cos \phi &= \cos \delta \cdot \cos z + \sin \delta \cdot \sin z \cdot \cos \varphi \\ \cos z &= \cos \delta \cdot \sin \phi + \sin \delta \cdot \cos \phi \cdot \cos H \\ \sin \delta &= \sin z \cdot \sin \phi + \cos z \cdot \cos \phi \cdot \cos A \end{aligned}$$

APP
SERRAL
CLASSE

$\phi, \delta, \varphi, \delta, \varphi, \delta$

$$\cos \phi = \sqrt{1 - \sin^2 \phi}$$

LA ECLIPTICA $\equiv E$



F. seno:

$$\frac{\sin A}{\sin \delta} = \frac{\sin H}{\sin \phi} = \frac{\sin \eta}{\sin \phi}$$

F. coseno:

$$\begin{aligned} \cos \phi &= \cos \delta \cdot \cos \eta + \sin \delta \cdot \sin \eta \cdot \cos H \\ \cos \delta &= \cos \phi \cdot \cos \eta + \sin \phi \cdot \sin \eta \cdot \cos H \\ \cos \eta &= \cos \delta \cdot \sin \phi + \sin \delta \cdot \cos \phi \cdot \cos H \end{aligned}$$

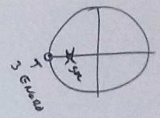
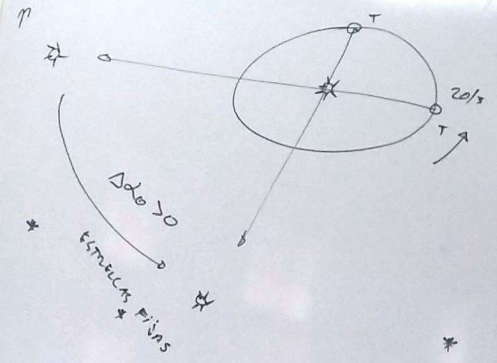
App Spherical trigonometry

$\phi, \delta, \eta \Rightarrow \phi$

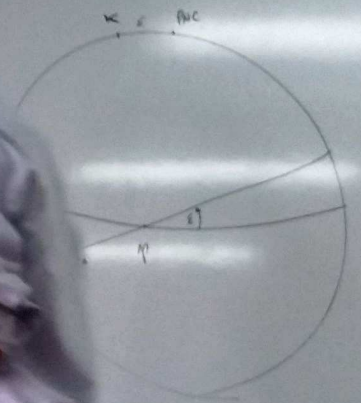
$$\cos \phi = \pm \sqrt{1 - \sin^2 \phi}$$

LA ECLÍPTICA \equiv ESFERA CELESTE \cap PLANO DE LA ECLÍPTICA
PLANO ORBITAL TERRESTRE

COORD. ECLIPTICAS



$\Sigma =$
OBLICU



APP
SISTEMA
CLASICO

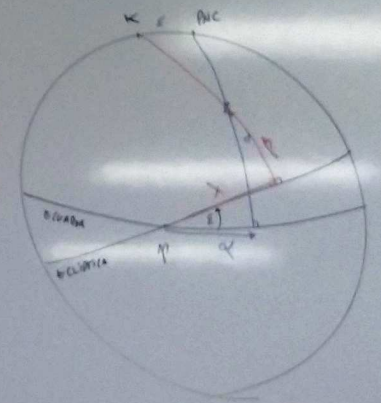
LA ECLIPTICA \equiv ESFERA CELESTE \cap PLANO DE LA ECLIPTICA
PLANO ORIGINAL TERRESTRE

COORD. ECLIPTICAS

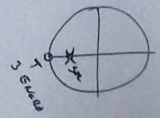
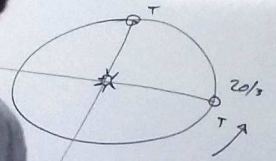
$\epsilon = 23^{\circ} 27'$

OBLICUIDAD

- $\lambda =$ LONGITUD ECLIPTICA $(0^{\circ}, 360^{\circ})$
- $\beta =$ LATITUD ECLIPTICA $(-90^{\circ}, +90^{\circ})$



APP
 SYSTEM
 CLOCK



COORD. ECUAL. CELESTES

(x, y, z)

LA ECLIPTICA \equiv ESFERA CELESTE \cap PLANO DE LA ECLIPTICA
PLANO ORIGINAL TERRESTRE

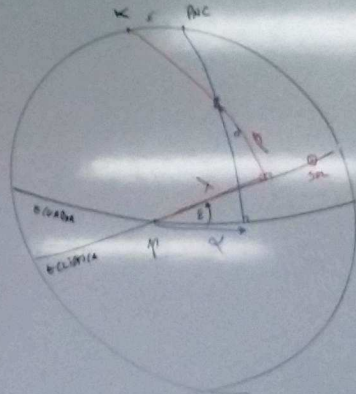
COORD. ECLIPTICAS

RECTANGULARES (x, y, z)
 ESFERICAS (λ, β)

$\epsilon = 23^\circ 27'$

OBLICUIDAD

$\lambda =$ LONGITUD ECLIPTICA
 $(0^\circ, 360^\circ)$
 $\beta =$ LATITUD ECLIPTICA
 $(-90^\circ, +90^\circ)$



$\beta_0 = 0^\circ$

APP
 SIDEREAL
 CLOCK

LA ECLÍPTICA \equiv ESFERA CELESTE \cap PLANO DE LA ECLÍPTICA
PLANO ORIGINAL TERRESTRE

CELESTES (x, y, z)
 (d.o)

$x =$
 $y =$
 $z =$

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = R_x(\epsilon) \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

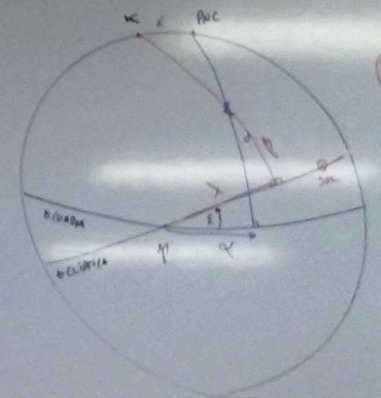
$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos \epsilon & \sin \epsilon \\ 0 & -\sin \epsilon & \cos \epsilon \end{pmatrix}$$

COORD. ECLÍPTICAS

RECTANGULARES (x, y, z)
 ESPHERICAS (λ, β)

$\epsilon = 23^\circ 27'$
 OBLICUIDAD

$\lambda =$ LONGITUD ECLÍPTICA
 $(0^\circ, 360^\circ)$
 $\beta =$ LATITUD ECLÍPTICA
 $(-90^\circ, +90^\circ)$



$\beta_0 = 0^\circ$

APP
 SYSTEM
 CLOCK

T. CELESTES

(x, y, z)
(d. d.)

$x = \cos \delta \cdot \cos \alpha$
 $y = \cos \delta \cdot \sin \alpha$
 $z = \sin \delta$

$\xi = x + 0 + 0$
 $\eta = 0 + y \cos \epsilon + z \sin \epsilon$
 $\zeta = 0 - y \sin \epsilon + z \cos \epsilon$

LA ECLIPTICA \equiv ESFERA CELESTE \cap PLANO DE LA ECLIPTICA
PLANO ORIGINAL TERRA-SOL

$$\begin{pmatrix} \xi \\ \eta \\ \zeta \end{pmatrix} = R_x(\epsilon) \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

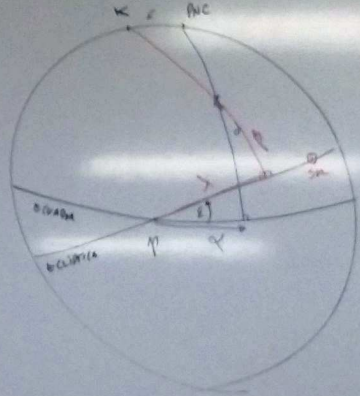
$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos \epsilon & \sin \epsilon \\ 0 & -\sin \epsilon & \cos \epsilon \end{pmatrix}$$

COORD. ECLIPTICAS

RECTANGULARES (ξ, η, ζ)
ESFERICAS (λ, β)

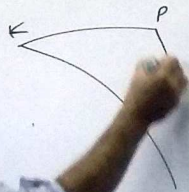
$\epsilon = 23^\circ 27'$
OBLICUIDAD

$\lambda =$ LONGITUD ECLIPTICA
($0^\circ, 360^\circ$)
 $\beta =$ LATITUD ECLIPTICA
($-90^\circ, +90^\circ$)



$\beta_0 = 0^\circ$

$\xi = \cos \beta \cdot \cos \lambda$
 $\eta = \cos \beta \cdot \sin \lambda$
 $\zeta = \sin \beta$



LA ECLIPTICA \equiv ESFERA CELESTE \cap PLANO DE LA ECLIPTICA ORIGINAL TERRESTRE

$$\begin{pmatrix} \xi \\ \eta \\ \zeta \end{pmatrix} = R_x(\epsilon) \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos \epsilon & \sin \epsilon \\ 0 & -\sin \epsilon & \cos \epsilon \end{pmatrix}$$

$$\xi = X + 0 + 0$$

$$\rho \cos \beta \cos \lambda = \rho \cos \delta$$

$$\eta = 0 + Y \cos \epsilon + Z \sin \epsilon$$

$$\zeta = 0 - Y \sin \epsilon + Z \cos \epsilon$$

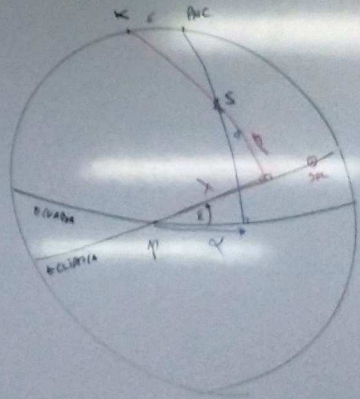
$$\rho \sin \beta = -\rho \sin \delta \cos \lambda + \rho \sin \delta \sin \lambda$$

COORD. ECLIPTICAS

RECTANGULARES (ξ, η, ζ)
ESFERICAS (λ, β)

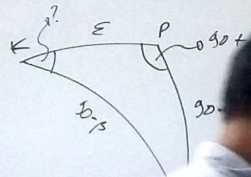
$\epsilon = 23^\circ 27'$
OBLICUIDAD

$\lambda =$ LONGITUD ECLIPTICA $(0^\circ, 360^\circ)$
 $\beta =$ LATITUD ECLIPTICA $(-90^\circ, +90^\circ)$



$\beta_0 = 0^\circ$

$$\begin{cases} \xi = \cos \beta \cdot \cos \lambda \\ \eta = \cos \beta \cdot \sin \lambda \\ \zeta = \sin \beta \end{cases}$$



LA ECLIPTICA \equiv ESFERA CELESTE \cap PLANO DE LA ECLIPTICA
PLANO ORIGINAL TERRESTRE

$$\begin{pmatrix} \xi \\ \eta \\ \zeta \end{pmatrix} = R_x(\epsilon) \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos \epsilon & \sin \epsilon \\ 0 & -\sin \epsilon & \cos \epsilon \end{pmatrix}$$

$$\xi = x + 0 + 0$$

$$\cos \epsilon \cos \lambda = \cos \delta - \sin \delta \sin \epsilon$$

$$\eta = 0 + y \cos \epsilon + z \sin \epsilon$$

$$\zeta = 0 - y \sin \epsilon + z \cos \epsilon$$

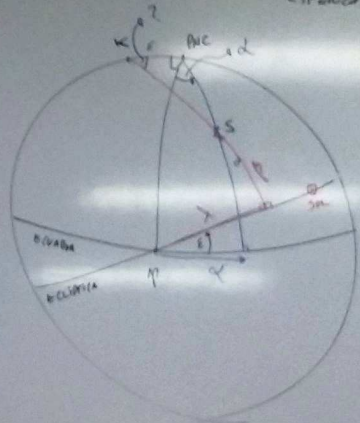
$$\sin \delta = -\cos \delta \sin \epsilon + \sin \delta \cos \epsilon$$

COORD. ECLIPTICAS

RECTANGULAS (x, y, z)
 ESFERICAS (λ, β)

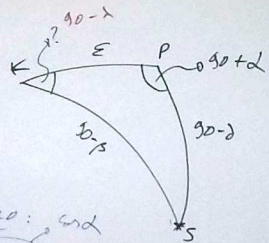
$\epsilon = 23^\circ 27'$
 OBLICUIDAD

$\lambda =$ LONGITUD ECLIPTICA
 ($0^\circ, 360^\circ$)
 $\beta =$ LATITUD ECLIPTICA
 ($-90^\circ, +90^\circ$)



$\beta_0 = 0^\circ$

$$\begin{cases} \xi = \cos \beta \cdot \cos \lambda \\ \eta = \cos \beta \cdot \sin \lambda \\ \zeta = \sin \beta \end{cases}$$



F. SENO:

$$\frac{\sin(90 + \delta)}{\sin(90 - \lambda)} = \frac{\sin(90 - \beta)}{\sin(90 - \delta)}$$

$\cos \delta = \sin \beta \cdot \cos \lambda$
 $\cos \delta = \sin \beta \cdot \cos \lambda$

$\Rightarrow \cos \delta \cdot \cos \lambda = \cos \beta$ ①

LA ECLIPTICA \equiv ESFERA CELESTE \cap PLANO DE LA ECLIPTICA
PLANO ORIGINAL TERRESTRE

$$\begin{pmatrix} \xi \\ \eta \\ \zeta \end{pmatrix} = R_x(\epsilon) \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos \epsilon & \sin \epsilon \\ 0 & -\sin \epsilon & \cos \epsilon \end{pmatrix}$$

$$\xi = X + 0 + 0$$

$\cos \delta \cdot \cos \lambda = \cos \delta \cdot \cos \lambda$ ①

$$\eta = 0 + Y \cos \epsilon + Z \sin \epsilon$$

$$\zeta = 0 - Y \sin \epsilon + Z \cos \epsilon$$

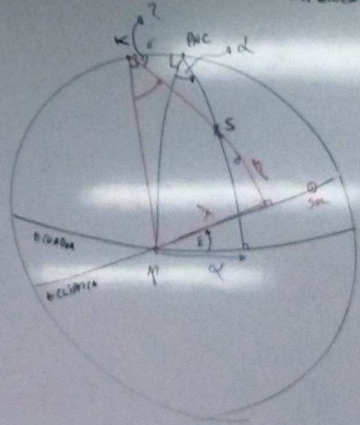
$\sin \beta = -\cos \delta \cdot \sin \lambda \cdot \sin \epsilon + \sin \delta \cdot \cos \epsilon$

COORD. ECLIPTICAS

RECTANGULAS (ξ, η, ζ)
 ESPHERICAS (λ, β)

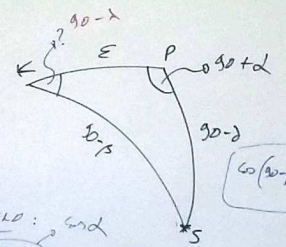
$\epsilon = 23^\circ 27'$
 OBLICUIDAD

$\lambda =$ LONGITUD ECLIPTICA
 ($0^\circ, 360^\circ$)
 $\beta =$ LATITUD ECLIPTICA
 ($-90^\circ, +90^\circ$)

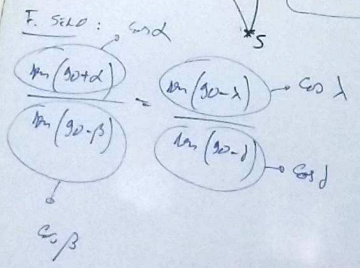


$$\begin{cases} \xi = \cos \beta \cdot \cos \lambda \\ \eta = \cos \beta \cdot \sin \lambda \\ \zeta = \sin \beta \end{cases}$$

LA ECLIPTICA \equiv ESFERA CELESTE \cap PLANO DE LA ECLIPTICA
PLANO ORIGINAL TERRA-SOL



$$\cos(90 - \rho) = \cos(90 - \delta) \cdot \cos \epsilon + \sin(90 - \delta) \cdot \sin \epsilon \cdot \cos(90 + \delta) \quad (2)$$



$$\Rightarrow \cos \delta \cdot \cos \epsilon = \cos \lambda \cdot \cos \beta \quad (1)$$

$$\xi = X + 0 + 0 \quad \rightarrow \cos \rho \cos \lambda = \cos \delta \cdot \cos \epsilon \quad (1)$$

$$\eta = 0 + Y \cos \epsilon + Z \sin \epsilon$$

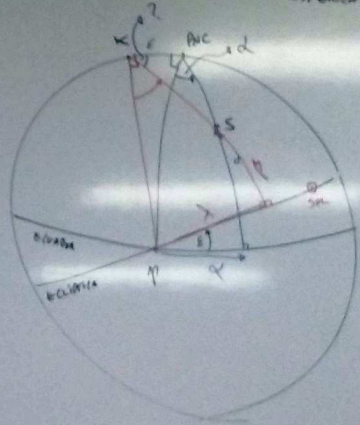
$$\zeta = 0 - Y \sin \epsilon + Z \cos \epsilon \quad \rightarrow \sin \rho = -\cos \delta \cdot \sin \epsilon \cdot \cos \lambda + \sin \delta \cdot \cos \epsilon \quad (2)$$

COORD. ECLIPTICAS

RECTANGULARES (x, y, z)
 ESFERICAS (λ, β)

$\epsilon = 23^\circ 27'$
 OBLICUIDAD

$\lambda =$ LONGITUD ECLIPTICA
 (0, 360°)
 $\beta =$ LATITUD ECLIPTICA
 (-90°, +90°)

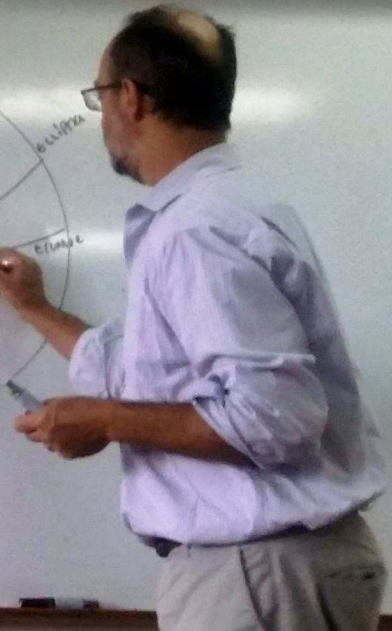
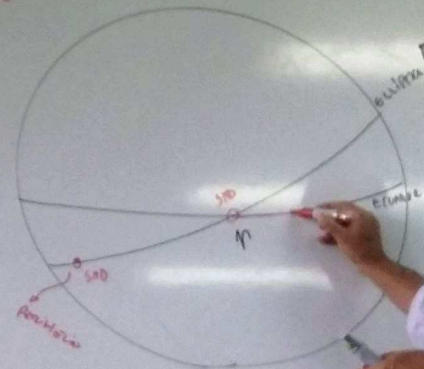


$\beta_0 = 0^\circ$

$$\begin{cases} z = \cos \beta \cdot \cos \lambda \\ \eta = \cos \beta \cdot \sin \lambda \\ \zeta = \sin \beta \end{cases}$$

TIEMPO → SIDÉREO : $H(\pi)$
 ↓
SOLAR → APARENTE : $S_{\text{V}} \text{ VISIBL}$
 ↓
 MEDID : SOL MEDID

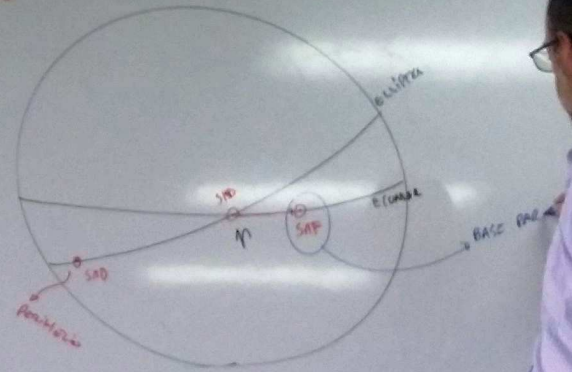
Sec. Medid Barrios } $\frac{\Delta \lambda_{\text{sol}}}{\Delta t} = c_{\text{TR}}$



TIEMPO → SIDÉREO : $H(\pi)$
 → SOLAR → APARENTE : s_{α} VISIBLE
 → MEDIO : SOL MEDIO

SOL MEDIO
BARRIDO } $\frac{\Delta \lambda_{SMD}}{\Delta t} = CTE$

SOL MEDIO
FUTURO }
"SOL MEDIO"
 $\frac{\Delta \lambda_{SF}}{\Delta t} = CTE$



TIEMPO SIDÉREO : $H(\pi)$

SOLAR
 APARENTE : S_{α} VISIBL
 MEDIO : S_{α} MEDIO

$$T. S_{\alpha} AP - T. S_{\alpha} MEDIO = H_{\theta} - H_{\varphi} = \\ = TSL - \alpha_{\theta} - (TSL - \alpha_{\varphi})$$

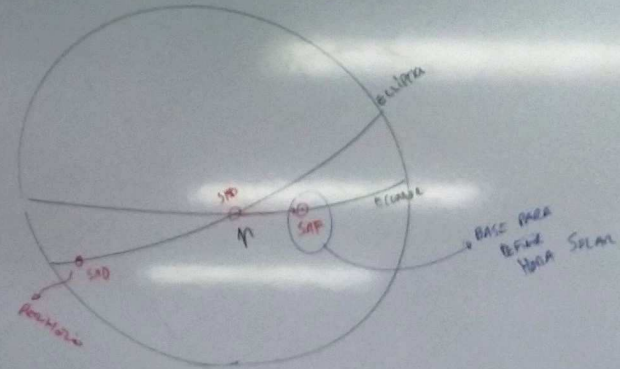
$$TSL = H + \alpha$$

$$T. SIDÉREO = H(\pi)$$

$$T. SOLAR APARENTE = H_{\theta}$$

$$T. SOLAR MEDIO = H_{\varphi}$$

↑
FICTIVO



TIEMPO SIDÉREO : $H(\pi)$
 SOLAR
 - APARENTE : SOL VISUAL
 - MEDIO : SOL MEDIO

$$T. \text{SIDÉREO} = H(\pi)$$

$$T. \text{SOLAR APARENTE} = H_0 + 12^h$$

$$T. \text{SOLAR MEDIO} = H_{SF} + 12^h$$

↑
FICTICIO

$$T. \text{Sol Ap} - T. \text{Sol Medio} = H_0 - H_{SF} =$$

$$= TSL - \alpha_0 - (TSL - \alpha_{SF})$$

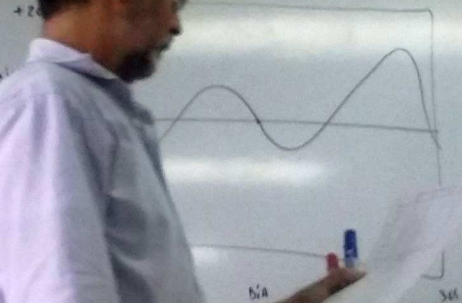
$$= \alpha_{SF} - \alpha_0$$

$$T. \text{Sol. Ap} - T. \text{Sol. Medio} = \alpha_{SF} - \alpha_0$$

ECLIPCIÓN DEL TIEMPO

↑
sumarse

$$TSL = H + \alpha$$



TIEMPO SIDÉREO : $H(\pi)$
 SOLAR
 - APARENTE : SOL VISIBLE
 - MEDIO : SOL MEDIO

$$T. Sol. Ap - T. Sol. Medio = H_0 - H_{sf} =$$

$$= TSL - (TSL - \alpha_{sf})$$

$$= \alpha_{sf}$$

$$T. Sol. Ap - T. Sol. Medio = \alpha_{sf}$$

ECLIPCIÓN DEL

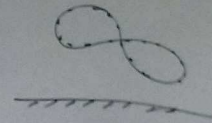
$$T. SIDÉREO = H(\pi)$$

$$T. SOLAR APARENTE = H_0 + 12^h$$

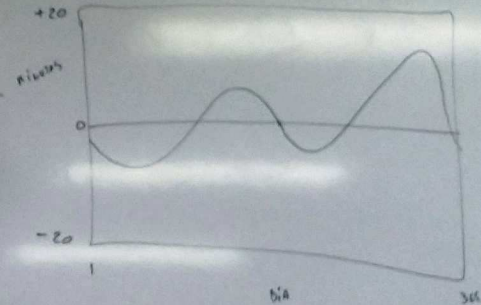
$$T. SOLAR MEDIO = H_{sf} + 12^h$$

↑
FICTICIO

$$TSL = H + \alpha$$



ANALEMA



Tiempo

T. Sol

T. Sol

T.

en visible

$$T. \text{Sol. Ap} - T. \text{Sol. Medio} = H_0 - H_{sf} =$$

$$= TSL - d_0 - (TSL - d_{sf})$$

$$= d_{sf} - d_0$$

$$T. \text{Sol. Ap} - T. \text{Sol. Medio} = d_{sf} - d_0$$

ECLIPSE DEL TIEMPO

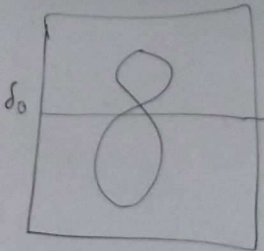
sumero

$$TSL = H + d$$

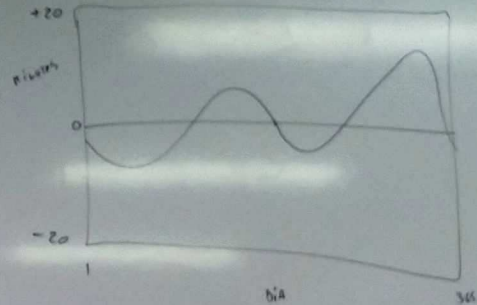
$$d_{sf} = 0$$



ALABAMA



$d_{sf} - d_0$



TIEMPO SIDÉREO : $H(\pi)$

SOLAR
 APARENTE : SOL VISIBL
 MEDIO : SOL MEDIO

$T. \text{ SIDÉREO} = H(\pi)$

$T. \text{ SOLAR APARENTE} = H_0 +$

$T. \text{ SOLAR MEDIO} = H_{SF} +$
FICTICIO

$T. \text{ SOL MEDIO} = H_0 - H_{SF} =$

$= TSL - \alpha_0 - (TSL - \alpha_{SF})$

$= \alpha_{SF} - \alpha_0$

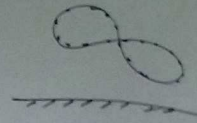
$\alpha_{SF} - \alpha_0$

variaci

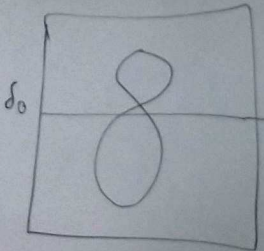
rios

$TSL = H + \alpha$

$\alpha_{SF} = 0$



ALABAMA



$\alpha_{SF} - \alpha_0$

