

TOPO - GEO - HELIO

MOV. POLAR

} ⇒ MOV. OBSERVADOR

PRECESIÓN Y NUTACIÓN

→ MOV. SIST. REFERENCIA

MOV. PROPIO  
(estrellas)

MOV. ORBITAL  
(S. Sol)

] ⇒ MOV. OBJETO

PARA  $h=0$ :

ÁNGULO DE LA VERTICAL

$$N = \phi' - \phi = -11' 32''.7 \cdot \sin(2\phi) + \dots$$

$$p = a \left( 0.998327 + 0.0016764 \cdot \cos(2\phi) + \dots \right)$$

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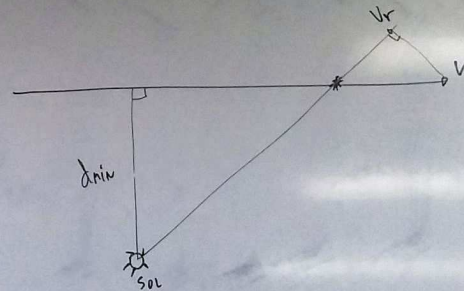
MOV. PROPIO  
(estrellas)

MOV. ORBITAL  
(S. Sol)

⇒ MOV. OBJETO

TIEMPO

5 MOV. PROPIO



TOPO - GEO - HELIO

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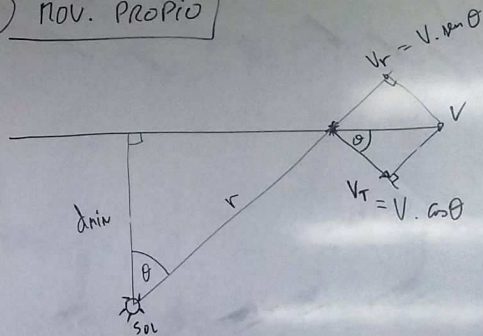
MOV. PROPIO  
(estrellas)

⇒ MOV. OBJETO

MOV. ORBITAL  
(S. SOL)

TIEMPO

5 MOV. PROPIO



$$V_r = V \cdot \sin \theta = \frac{dr}{dt}$$

$$V_t = V \cdot \cos \theta = r \cdot \frac{d\theta}{dt}$$

TOPO - GEO - HELIO

MOV. POLAR

⇒ MOV. OBSERVADOR

PRECESIÓN Y NUTACIÓN

⇒ MOV. SIST. REFERENCIA

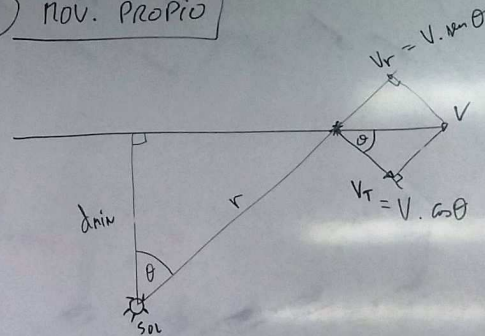
MOV. PROPIO  
(esmales)

MOV. ORBITAL  
(s. solar)

⇒ MOV. OBJETO

TIEMPO

5 MOV. PROPIO

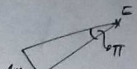


$$V_r = V \cdot \cos \theta = \frac{dr}{dt}$$

$$V_t = V \cdot \sin \theta = r \cdot \frac{d\theta}{dt}$$

$$\frac{d\theta}{dt} = V_t \cdot \frac{1}{r} = \pi (\text{rads}) \cdot V_t \rightarrow \text{UA/Año}$$

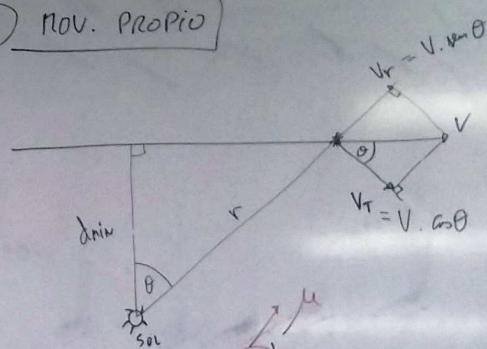
$$V_T (u_A/A_{10}) = V_T \times \frac{150 \times 10^6 \text{ km}}{r}$$



$$\frac{100 \text{ AU}}{r} = \sin \theta$$

$$\theta (\text{rads}) = \frac{100}{r \cos \theta}$$

5 NOV. PROPIO



$$V_r = V \cos \theta = \frac{dr}{dt}$$

$$V_T = V \sin \theta = r \frac{d\theta}{dt}$$

$$\frac{d\theta}{dt} = V_T \cdot \frac{1}{r} = \pi (\text{rads}) \cdot V_T$$

$$\Rightarrow \frac{d\theta}{dt} = \pi^{(u)} \cdot V_T (u_A/A_{10})$$

$$V_T \text{ (ua/año)} = V_T \times \frac{150 \times 10^6 \text{ km}}{365.25 \times 24 \times 60 \times 60}$$

Km/sec

4.74



$$\sin \pi = \frac{1 \text{ ua}}{r}$$

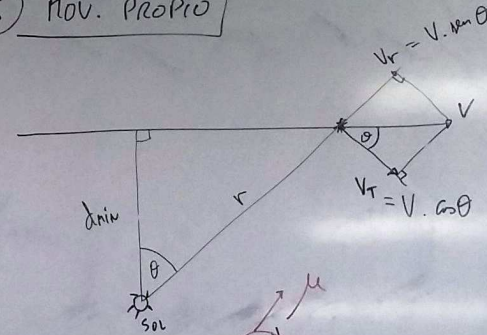
$$\pi \text{ (rads)} = \frac{1 \text{ ua}}{r \text{ (uas)}}$$

$$\mu = 4.74 \cdot \pi \cdot V_T$$

Km/sec

ua/año

5 NOV. PROPIO



$$V_r = V \cdot \cos \theta = \frac{dr}{dt}$$

$$V_T = V \cdot \sin \theta = r \cdot \frac{d\theta}{dt}$$

$$\frac{d\theta}{dt} = V_T \cdot \frac{1}{r} = \pi \text{ (rads)} \cdot V_T$$

ua/año

$$\Rightarrow \frac{d\theta}{dt} = \pi \text{ (")}. V_T \text{ (ua/año)}$$

Año

$$V_T (u/a) = V_T \times \frac{150 \times 10^6 \text{ km}}{365.25 \times 24 \times 60 \times 60}$$

Km/sec

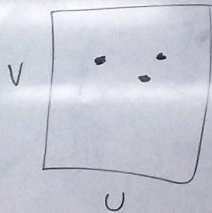
4.74

$$\mu = \pi \frac{v}{r}$$

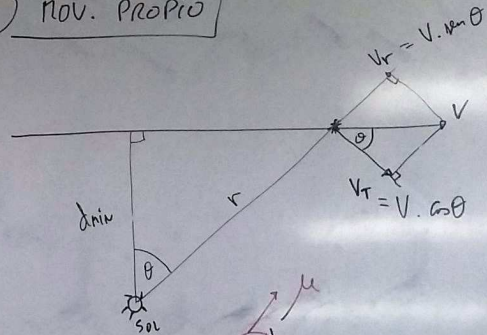
$$\pi (\text{rads}) = \frac{v}{r (\text{rads})}$$

$$\mu = 4.74 \cdot \pi \cdot V_T$$

Km/sec



5 NOV. PROPIO



$$v_r = v \cdot \sin \theta = \frac{dr}{dt}$$

$$v_T = v \cdot \cos \theta = r \cdot \frac{d\theta}{dt}$$

$$\frac{d\theta}{dt} = v_T \cdot \frac{1}{r} = \pi (\text{rads}) \cdot V_T$$

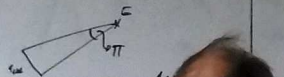
u/a / A u

$$\Rightarrow \frac{d\theta}{dt} = \pi (\text{rads}) \cdot V_T (u/a)$$

A u

$$V_T \left( \frac{m}{A^2} \right) = \frac{V_T \times \frac{150 \times 10^6 \text{ km}}{365.25 \times 24 \times 60 \times 60}}{\text{km/sec}}$$

4.74

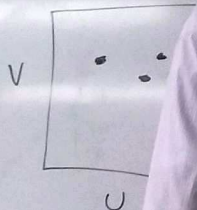


$$\mu = \frac{1 \text{ arcsec}}{206265} = \frac{1}{206265}$$

$$\mu \text{ (mas)} = \frac{1}{206265000}$$

$$\mu = 4.74 \cdot \mu \cdot V_T$$

km/sec



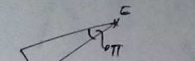
EFFECT



$$V_T (u_a / a_{70}) = V_T \times \frac{150 \times 10^6 \text{ km}}{365.25 \times 24 \times 60 \times 60}$$

Km/sec

4.74

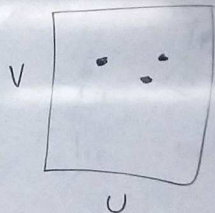
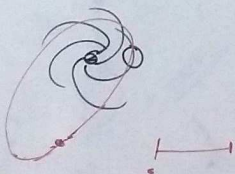


$$10 \rightarrow \Pi = \frac{1 u_a}{r}$$

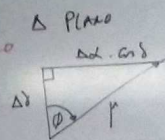
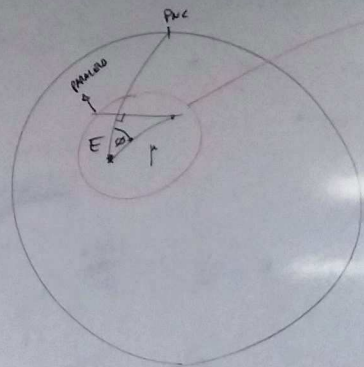
$$\Pi (\text{mas}) = \frac{1 u_a}{r (\text{mas})}$$

$$M = 4.74 \cdot \frac{\Pi}{\sin i} \cdot V_T$$

$\frac{M}{M_{\odot}}$       Km/sec



EFFECTO EN  $\alpha$  y  $\delta$



$$\left\{ \begin{aligned} \Delta \alpha \cdot \cos \delta &= \mu \cdot \sin \phi \\ \Delta \delta &= \mu \cdot \cos \phi \end{aligned} \right.$$



$$V_T (\text{ua/año}) = V_T \times \frac{150 \times 10^6 \text{ km}}{365.25 \times 24 \times 60 \times 60}$$

Km/sec

4.74

CATÁLOGO:

2000.0

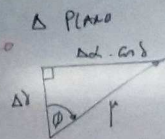
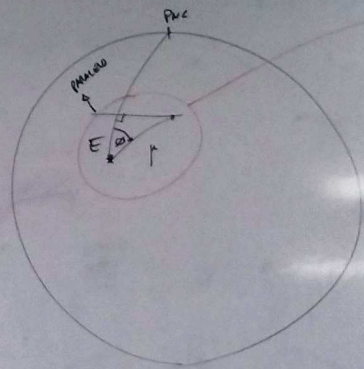
$\alpha, \delta, \mu_\alpha, \mu_\delta$

$$\mu = 4.74 \cdot \frac{\mu}{\text{año}} \cdot V_T$$

Km/sec



EFFECTO EN  $\alpha, \delta$



$$\begin{cases} \Delta \alpha \cdot \cos \delta = \mu \cdot \sin \phi \\ \Delta \delta = \mu \cdot \cos \phi \end{cases}$$

$$\mu \text{ (año)} = \frac{\mu \text{ (año)}}{\cos \delta} \cdot \frac{1}{15}$$

$$\mu \text{ (año)} (\Delta \delta) = \mu \cos \phi$$

$$\Rightarrow \begin{cases} \mu_\alpha = \frac{1}{15} \cdot \mu \cdot \sin \phi / \cos \delta \\ \mu_\delta = \mu \cdot \cos \phi \end{cases}$$

$$V_T (\text{ua/año}) = V_T \times \frac{150 \times 10^6 \text{ km}}{365.25 \times 24 \times 60 \times 60}$$

Km/sec

4.74

CATÁLOGO:

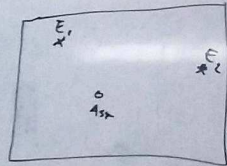
2000.0

$\alpha, \delta, \mu_\alpha, \mu_\delta$

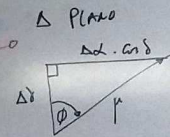
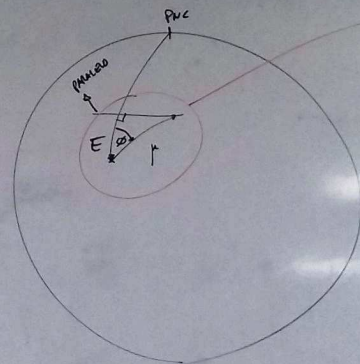
$$\mu = 4.74 \cdot \frac{V_T}{d}$$

Km/sec

$\frac{\mu}{\text{año}}$



EFFECTO EN  $\alpha, \delta$



$$\begin{cases} \Delta \alpha \cdot \cos \delta = \mu \cdot \sin \phi \\ \Delta \delta = \mu \cdot \cos \phi \end{cases}$$

$$\Delta \alpha = \frac{\mu \cdot \sin \phi}{\cos \delta} \cdot \frac{1}{15}$$

$$\Delta \delta = \mu \cdot \cos \phi$$

$$\Rightarrow \begin{cases} \mu_\alpha = \frac{1}{15} \cdot \mu \cdot \sin \phi / \cos \delta \\ \mu_\delta = \mu \cdot \cos \phi \end{cases}$$

$$V_T (\mu\text{a}/\text{Año}) = V_T \times \frac{150 \cdot 10^6 \text{ km}}{365.25 \times 24 \times 60 \cdot 60}$$

Km/Sec

4.74

CATÁLOGO:

2000.0

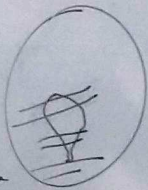
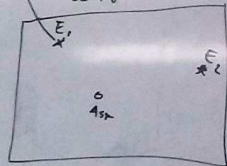
$\alpha, \delta, \mu_\alpha, \mu_\delta$

$$\mu = 4.74 \cdot \frac{V_T}{r}$$

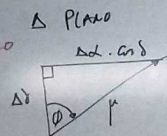
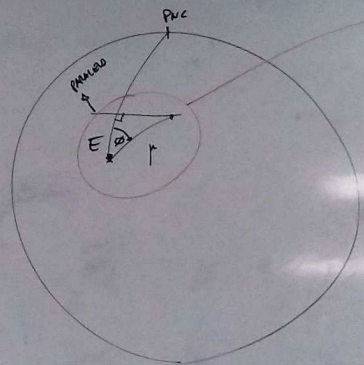
$\mu/\text{Año}$

$\alpha_{2000} + \mu_\alpha \cdot 18$

2018



EFFECTO EN  $\alpha, \delta$



$$\begin{cases} \Delta \alpha \cdot \cos \delta = \mu \cdot \sin \phi \\ \Delta \delta = \mu \cdot \cos \phi \end{cases}$$

$$\Delta \alpha = \frac{\mu \cdot \sin \phi}{\cos \delta} \cdot \frac{1}{15}$$

$$\Delta \delta = \mu \cdot \cos \phi$$

$$\begin{aligned} \mu_\alpha &= \frac{1}{15} \cdot \mu \cdot \sin \phi / \cos \delta \\ \mu_\delta &= \mu \cdot \cos \phi \end{aligned}$$

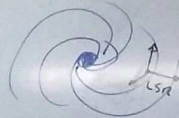
$$V_T (M/AU) = \frac{V_T}{\text{Km/sec}} \times \frac{150 \cdot 10^6 \text{ Km}}{365.25 \times 24 \times 60 \cdot 60}$$

4.74

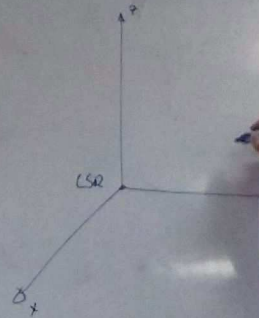
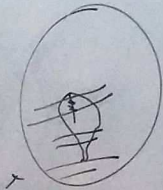
$$\vec{V}_* - \vec{V}_\odot = \underbrace{(\vec{V}_* - \vec{V}_{LSR})}_{\mu \text{ peculiar}} - \underbrace{(\vec{V}_\odot - \vec{V}_{LSR})}_{\mu \text{ galactico}}$$

$$M = 4.74 \cdot \frac{d}{\text{Kpc}} \cdot V_T$$

Km/sec



$$V_{LSR} \approx 220 \text{ Km/sec}$$



$$V_T (U^*/A^*) = V_T \times \frac{150 \times 10^6 \text{ km}}{355,25 \text{ km/sec}}$$

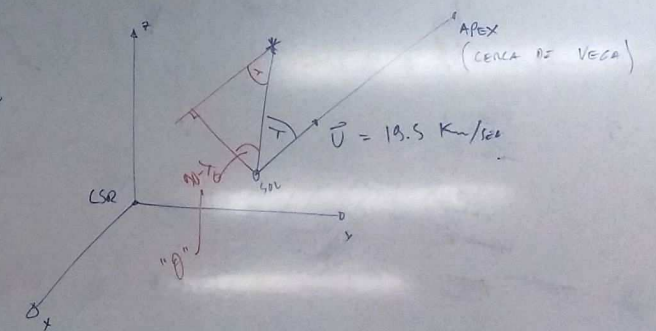
↑  
Km/sec

$$\vec{V}_* - \vec{V}_\odot = \underbrace{(\vec{V}_* - \vec{V}_{LSR})}_{\mu \text{ Peculiar}} - \underbrace{(\vec{V}_\odot - \vec{V}_{LSR})}_{\mu \text{ Paral\u00e1tico}}$$

$$V_T = V$$

$$\mu = 4.74 \cdot \frac{V}{d}$$

↓  
m/AU



$$V_T \text{ (ua/ano)} = \underset{\substack{\uparrow \\ \text{Km/sec}}}{V_T} \times \left( \frac{150 \cdot 10^6 \text{ Km}}{365.25 \times 24 \times 60 \cdot 60} \right)^{-1}$$

4.74

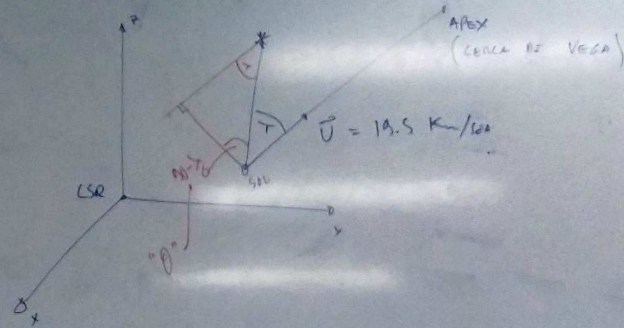
$$\vec{V}_* - \vec{V}_\odot = \underbrace{(\vec{V}_* - \vec{V}_{LSR})}_{\mu \text{ peculiar}} - \underbrace{(\vec{V}_\odot - \vec{V}_{LSR})}_{\mu \text{ paraláctico}}$$

$$\mu = [4.74]^{-1} \cdot \frac{V_T}{d} \rightarrow \text{Km/sec}$$

$\frac{V_T}{d}$

$$V_T = V \cdot \sin \theta$$

$$V_T \text{ (paraláctica)} = U \cdot \sin \lambda$$







$$V_T (U^*/A^*) = V_T \times \left( \frac{150 \times 10^6 \text{ km}}{355,25 \times 24 \times 60,40} \right)^{-1}$$

Km/sec

4,74

$$\vec{V}_* - \vec{V}_\odot = (\vec{V}_* - \vec{V}_{LSR}) - (\vec{V}_\odot - \vec{V}_{LSR})$$

μ peculiar

$$= (\vec{V}_\odot - \vec{V}_{LSR})$$

μ paraliática

$$V_T = V \cdot \sin \lambda$$

$$V_T \text{ (paraliática)} = U \cdot \sin \lambda$$

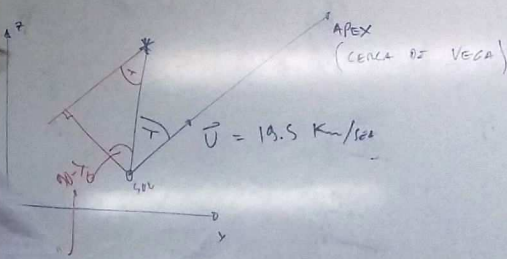
$$\mu = [4.74]^{-1} \cdot \frac{\pi}{d} \cdot V_T$$

Km/sec

μ/A^\*

$$\mu_{\text{paraliática}} = \frac{\pi \cdot U \cdot \sin \lambda}{4,74}$$

H



$$V_T (U^*/A70)$$

K<sub>r</sub>

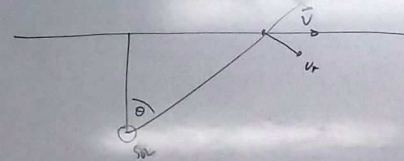
$$\vec{V}_* - \vec{V}_\odot = (\vec{V}_* - \vec{V}_{LSR}) - (\vec{V}_\odot - \vec{V}_{LSR})$$

$\mu_{\text{paraláxico}}$

$\mu_{\text{paraláxico}}$

ACELERACIÓN DE PERSPECTIVA

$$\frac{d\mu}{dt}$$



$$V_T = V \cdot \sin \theta$$

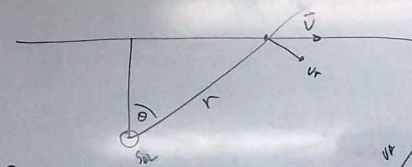
$$V_T (\text{paraláxico}) = U \cdot \sin \theta$$

$$\mu_{\text{paraláxico}} = \frac{\pi \cdot U \cdot \sin \theta}{4,74}$$

H

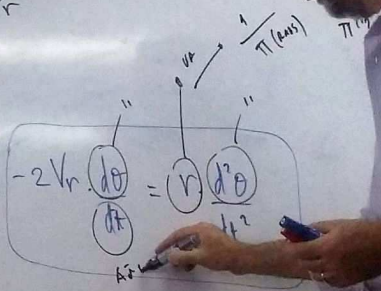


ACELERACIÓN DE PERSPECTIVA



$$V_r = V \cdot \cos \theta = r \cdot \frac{d\theta}{dt}$$

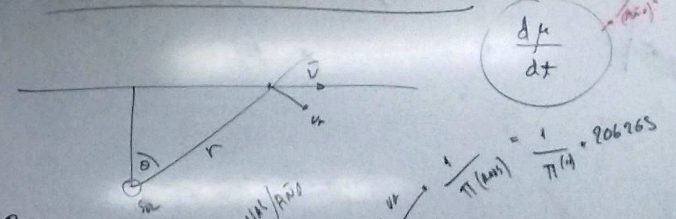
$$- \underbrace{V \cdot \sin \theta}_{V_r} \cdot \frac{d\theta}{dt} = \underbrace{\frac{dr}{dt}}_{V_r} \cdot \frac{d\theta}{dt} + r \cdot \frac{d^2\theta}{dt^2} \Rightarrow -2V_r \frac{d\theta}{dt} = r \frac{d^2\theta}{dt^2}$$



$$\frac{d^2\theta}{dt^2} = -\frac{2}{r} \cdot V_r \cdot \frac{d\theta}{dt} = -2 \cdot \frac{\pi^{(r)}}{206265} \cdot \frac{d\theta}{dt} \cdot V_r (U_r/A_{r0})$$

$V_r (km/sec) / 4.74$

ACELERACIÓN DE PERSPECTIVA



$$V_r = V \cdot \cos\theta = r \cdot \frac{d\theta}{dt}$$

$$-V_r \cdot \sin\theta \cdot \frac{d\theta}{dt} = \frac{dr}{dt} \cdot \frac{d\theta}{dt} + r \cdot \frac{d^2\theta}{dt^2}$$

$$\Rightarrow -2V_r \frac{d\theta}{dt} = r \frac{d^2\theta}{dt^2}$$

$\frac{1}{\pi^{(r)}} = \frac{1}{\pi^{(r)}} \cdot 206265$

$$\frac{d\mu}{dt}$$

$$\frac{d^2\theta}{dt^2} = -\frac{2}{r} \cdot V_r \cdot \frac{d\theta}{dt}$$

$\frac{d\theta}{dt} = \frac{\pi(\text{rad})}{206265}$

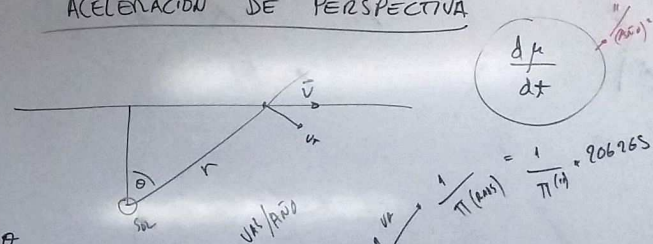
$$\frac{d\mu}{dt} = -\frac{2}{r} \cdot V_r \cdot \frac{d\theta}{dt}$$

$V_r (\text{km/s}) / 4.74$

$$\frac{d\mu}{dt} = -\frac{2}{4.74 \cdot 206265} \cdot \pi \cdot \mu \cdot V_r = \frac{d\mu}{dt}$$

AC. DE PERSPECTIVA

ACELERACIÓN DE PERSPECTIVA



$$V_r = V \cos \theta = r \cdot \frac{d\theta}{dt}$$

$$-V \sin \theta \cdot \frac{d\theta}{dt} = \frac{dr}{dt} \cdot \frac{d\theta}{dt} + r \cdot \frac{d^2\theta}{dt^2}$$

$$\Rightarrow -2V_r \frac{d\theta}{dt} = r \frac{d^2\theta}{dt^2}$$

$$\frac{d\mu}{dt} = \frac{1}{\pi(\text{mas})} = \frac{1}{\pi(\text{rad})} \cdot 206265$$

$$\frac{d^2\theta}{dt^2} = -\frac{2}{r} \cdot V_r \cdot \frac{d\theta}{dt} = -2 \cdot \frac{\pi(\text{rad})}{206265} \cdot \frac{d\theta}{dt} \cdot V_r (V_r / \text{año})$$

$$\frac{d\mu}{dt} = \frac{-2}{4.74 \cdot 206265} \cdot \pi \cdot \mu \cdot V_r = -2,05 \times 10^{-6} \cdot \pi \cdot \mu \cdot V_r = \frac{d\mu}{dt}$$

AC. DE PERSPECTIVA

GRAVITACIONAL



$$\frac{d^2\theta}{dt^2} = -\frac{2}{r} \cdot V_r \cdot \frac{d\theta}{dt} = -2 \cdot \frac{\pi(\text{rad})}{206265} \cdot \frac{d\theta}{dt} \cdot V_r \left(\frac{\text{km}}{\text{seg}}\right)$$

$$\frac{d\mu}{dt} = \frac{-2}{4.74 \cdot 206265} \cdot \pi \cdot \mu \cdot V_r = -2,05 \cdot 10^{-6} \cdot \pi \cdot \mu \cdot V_r = \frac{d\mu}{dt}$$

AC. DE PERSPECTIVA

DESVIÓ GRAVITACIONAL

$$\Delta\theta \cong \frac{GM}{R \cdot c^2} \cdot 4$$

