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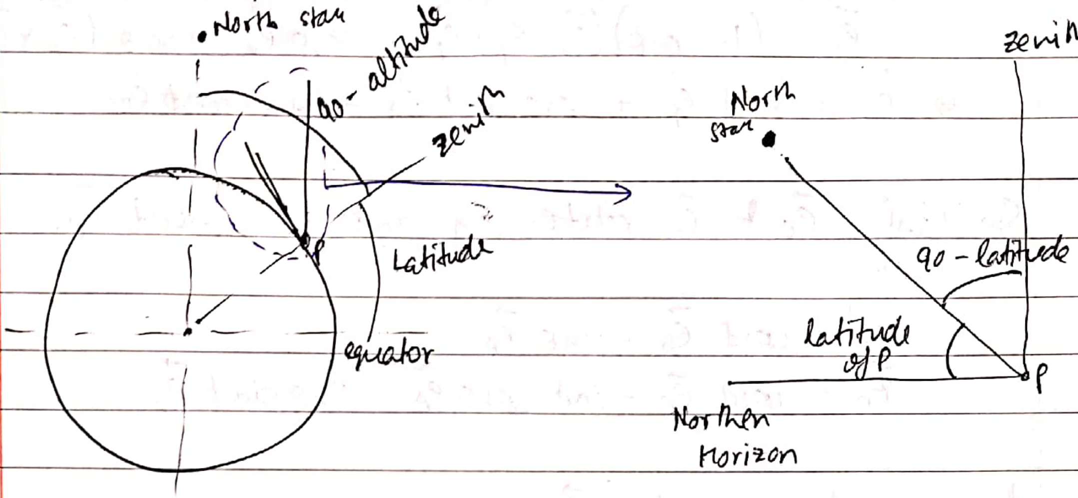
Q.1) $\vec{e}_P \equiv$ pole star

$\vec{e}_A =$ first point of Aries

$\vec{e}_B =$ $\perp$ to e_P & e_A

local vectors: e_v, e_n, e_e

observer, north, east



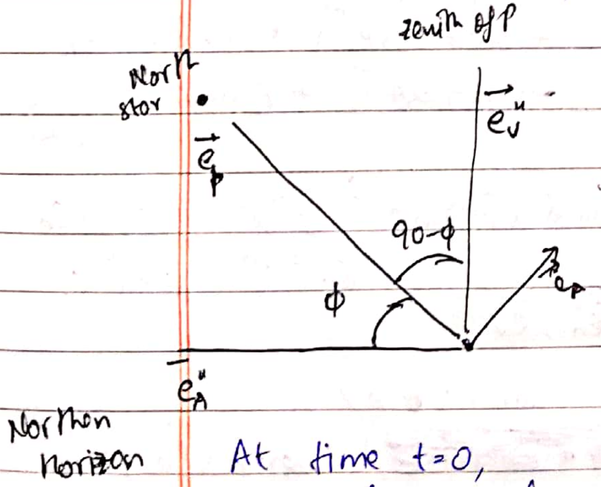
local vector rotates with the earth (e_v, e_e, e_n) and we will apply Rodriguez Rotation Eq. to find their position.

Rodriguez Rot. eq $\rightarrow$ $\bar{V}_{rot} = (1-\cos\theta)(\bar{v}\cdot\bar{u})u + \bar{v}\cos\theta + (\bar{u}\times\bar{v})\sin\theta$

[u: a vector along the axis of rotation]

after rotation by some angle θ,

e_v becomes e_v'' ; e_n becomes e_n'' , e_e becomes e_e''.



ϕ: latitude of P

~~$\vec{e}_A = \cos\phi\,\vec{e}_v'' - \sin\phi\,\vec{e}_n''$~~

$\vec{e}_p = \sin\phi\,\vec{e}_v'' + \cos\phi\,\vec{e}_n''$

At time $t=0$,

$\hat{e}_v = \cos\phi\,\hat{e}_A + \sin\phi\,\hat{e}_p$

$\hat{e}_e = \hat{e}_B$

$\hat{e}_n = \hat{e}_v \times \hat{e}_e = (\cos\phi\,\hat{e}_p - \sin\phi\,\hat{e}_A)$

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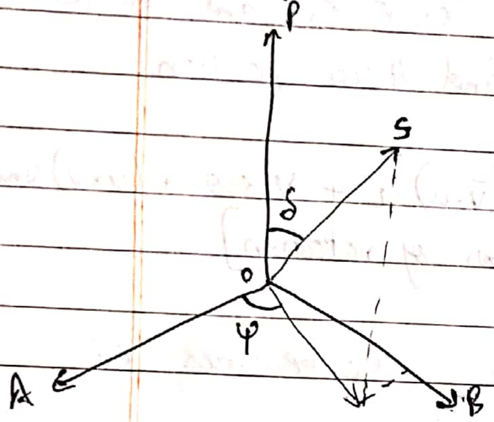
After time t
local vector $\vec{e}_v$ changes to $\vec{e}_v{}''$ by rotating 'θ' angle about $\vec{e}_p$.
Using rodriguez rotation.

$$\vec{e}_v{}'' = (1-\cos\theta)(\vec{e}_v \cdot \vec{e}_p)\,\vec{e}_p + \cos\theta\,\vec{e}_v + \sin\theta\,(\vec{e}_p \times \vec{e}_v)$$
$$\Rightarrow \vec{e}_v{}'' = \sin\phi\,\vec{e}_p + \cos\theta\cos\phi\,\vec{e}_A + \sin\theta\cos\phi\,\hat{e}_B$$

Similarly, $\vec{e}_e$ & $\vec{e}_n$ rotates by angle θ about $\vec{e}_p$.

$$\vec{e}_e{}'' = \cos\phi\,\vec{e}_B - \sin\theta\,\vec{e}_A$$
$$\vec{e}_n{}'' = \cos\phi\,\vec{e}_p - \sin\phi\cos\theta\,\vec{e}_A - \sin\theta\sin\phi\,\vec{e}_B$$

for any fixed vector $\vec{e}_s$ in space,



$$\vec{e}_s = \vec{e}_p\cos\delta + \sin\delta\cdot\cos\psi\cdot\vec{e}_A + \sin\delta\cdot\sin\psi\cdot\vec{e}_B$$

Substituting value of $\vec{e}_p$,

$$\vec{e}_s = (\cos\delta\sin\phi\,e_v{}'' + \cos\delta\cos\phi\,e_n{}'') + \sin\delta\cos\psi\,\vec{e}_A + \sin\delta\sin\psi\,\vec{e}_B \quad \cancel{+ r_1\cos\theta\,\vec{V}_1 + r_2\sin\theta\,\vec{V}_2} \quad (A)$$

~~where~~ $\cancel{r_1 V_1 = (\sin\delta\cos\psi\cos\phi\,\vec{e}_v{}'') \ldots \sin\delta\cos\psi\sin\phi\,\vec{e}_n{}'' \ldots (\sin\delta)(\sin\psi)\,\vec{e}_e{}''}$
$\cancel{r_2 V_2 = (\sin\delta\sin\psi\cos\phi\,\vec{e}_v{}'' - \sin\delta\cos\psi\,\vec{e}_e{}'' - (\sin\delta)(\sin\psi)(\sin\phi)\,\vec{e}_n{}''}$

write $\vec{e}_A, \vec{e}_B$ in terms of $\vec{e}_e{}'', \vec{e}_n{}'', \vec{e}_v{}''$

$$\vec{e}_A = \cos\psi\,(\cos\phi\,\vec{e}_v{}'' - \sin\phi\,\vec{e}_n{}'') + \sin\psi\,(\vec{e}_e{}'')$$
$$\vec{e}_B = \sin\psi\,(\cos\phi\,\vec{e}_v{}'' - \sin\phi\,\vec{e}_n{}'') - \cos\psi\,(\vec{e}_e{}'')$$

put values of $\vec{e}_A$ & $\vec{e}_B$ in (A) to get

$$\vec{e}_s = (\cos\delta\sin\phi\,\vec{e}_v{}'' + \cos\delta\cos\phi\,\vec{e}_n{}'') + r_1\cos\theta\,\vec{V}_1 + r_2\sin\theta\,\vec{V}_2$$

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where $\theta = \psi$

$$r_1 \vec{v}_1 = \sin\delta \left[\cos\psi \left(\cos\phi\ \vec{e}_v'' - \sin\phi\ \vec{e}_n'' \right) + \sin\psi \left(\vec{e}_e'' \right) \right]$$

and

$$r_2 \vec{v}_2 = \sin\delta \left[\sin\psi \left(\cos\phi\ \vec{e}_v'' - \sin\phi\ \vec{e}_n'' \right) - \cos\psi \left(\vec{e}_e'' \right) \right]$$

Q.2) Planet: Mars

i) Altitude: $+54° \ 12' \ 51.9'' = 54.2°$

Azimuth: $+245° \ 55' \ 17.4'' = 245.92°$

Star: Rigil Kentarus

ii) Altitude: $-54° \ 42' \ 17.4'' = -54.7°$

Azimuth: $+170° \ 26' \ 20.8'' = 170.43°$

Mar dist = 0.748 AU   Star dist: 4.3 ly

North comp. = (distance) . cos(altitude) cos(azimuth)

East comp = (distance). cos(altitude) sin(azimuth)

Vertical comp = (distance). sin(elevation)

Scanned with CamScanner