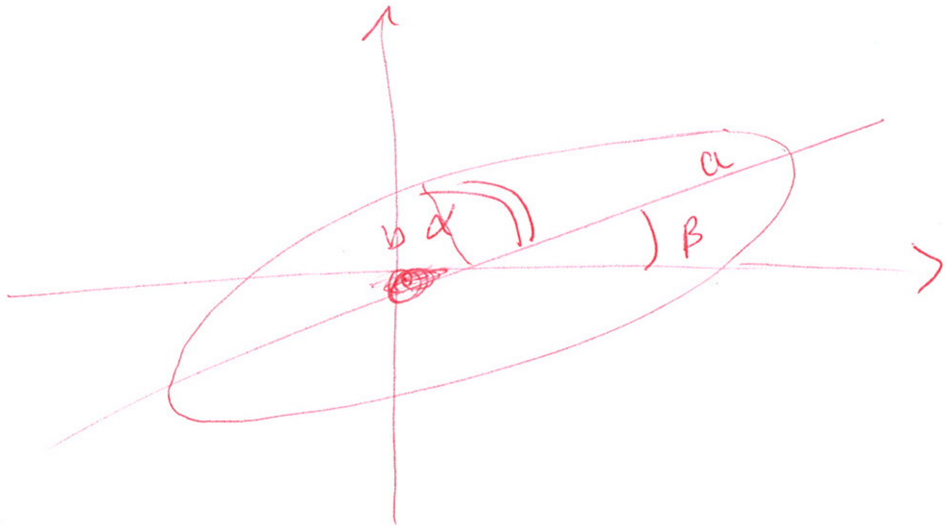


$$X(\gamma) = X_c + a\cos\gamma\cos\beta + b\sin\gamma\sin\beta$$

$$Y(\gamma) = Y_c + a\cos\gamma\sin\beta + b\sin\gamma\cos\beta$$

$$e = \sqrt{\frac{a^2-b^2}{a^2}} = 0.5975$$

<u>Borealis</u>

$a = 5{,}300$ km

$b = 4{,}250$ km.

$\beta = 14^\circ$ (N76°E).

$(Y_c, X_c) = (67^\circ N, 208^\circ E)$

$$\frac{dX}{d\gamma} = -a\sin\gamma\cos\beta + b\cos\gamma\sin\beta$$

$$\frac{dY}{d\gamma} = -a\sin\gamma\sin\beta + b\cos\gamma\cos\beta$$

Put ~~ex~~ $a_x = a\cos\beta$ $b_x = b\sin\beta$ Jan 4th

$a_y = a\sin\beta$ $b_y = b\cos\beta$

$$\left.\begin{aligned} X(\gamma) &= X_c + a_x\cos\gamma + b_x\sin\gamma \\ Y(\gamma) &= y_c + a_y\cos\gamma + b_y\sin\gamma \end{aligned}\right] \boxed{A}$$

$\boxed{\gamma = 0 : 2\pi}$

$$\left.\begin{aligned} \frac{dx}{d\gamma} &= -a_x\sin\gamma + b_x\cos\gamma \\ \frac{dy}{d\gamma} &= -a_y\sin\gamma + b_y\cos\gamma \end{aligned}\right] \boxed{B}$$

Eqns tang normal line to ellipse www.opensourcemath.org

Equation of tangent line @ point of contact

$$y - y_1 = \left(\frac{dy}{dx}\bigg|_{x=x_1,\, y=y_1}\right)(x - x_1)$$

and

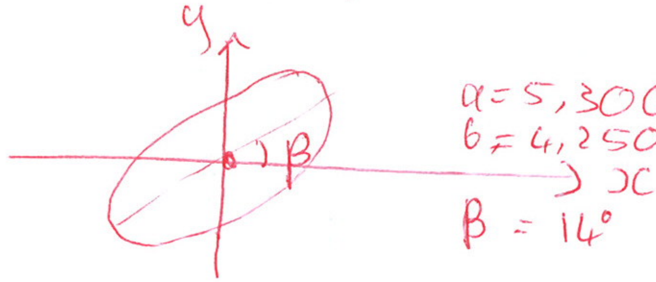
$$\frac{dy}{dx} = \frac{dy}{d\gamma} \cdot \frac{1}{\frac{dx}{d\gamma}}$$

Eqn normal line

$$(y - y_1) = -\left(\frac{dx}{dy}\bigg|_{x=x_1,\, y=y_1}\right)(x - x_1) \quad \boxed{C}$$

$$\frac{dx}{dy} = \frac{dx}{d\gamma} \cdot \frac{1}{\frac{dy}{d\gamma}}$$

1) generate x, y coords of an ellipse centered on (0,0) but oriented like Borealis



$a = 5{,}300$ (km)
$b = 4{,}250$ (km)
$\beta = 14°$

~~Assume x,y in~~

0,0

x, y will be in km.

~~use a small dγ so x, y fairly close~~
use $d\gamma$ = ~~...~~ 1° (prob OK)

2) @ each (x_i, y_i) on ellipse ie @ each γ_i

generate eqn of normal to ellipse

$$y = y_i + \left(\frac{-dx}{dy}\right)\bigg|_{x=x_i,\ y=y_i} (x - x_i)$$

$\boxed{D}$

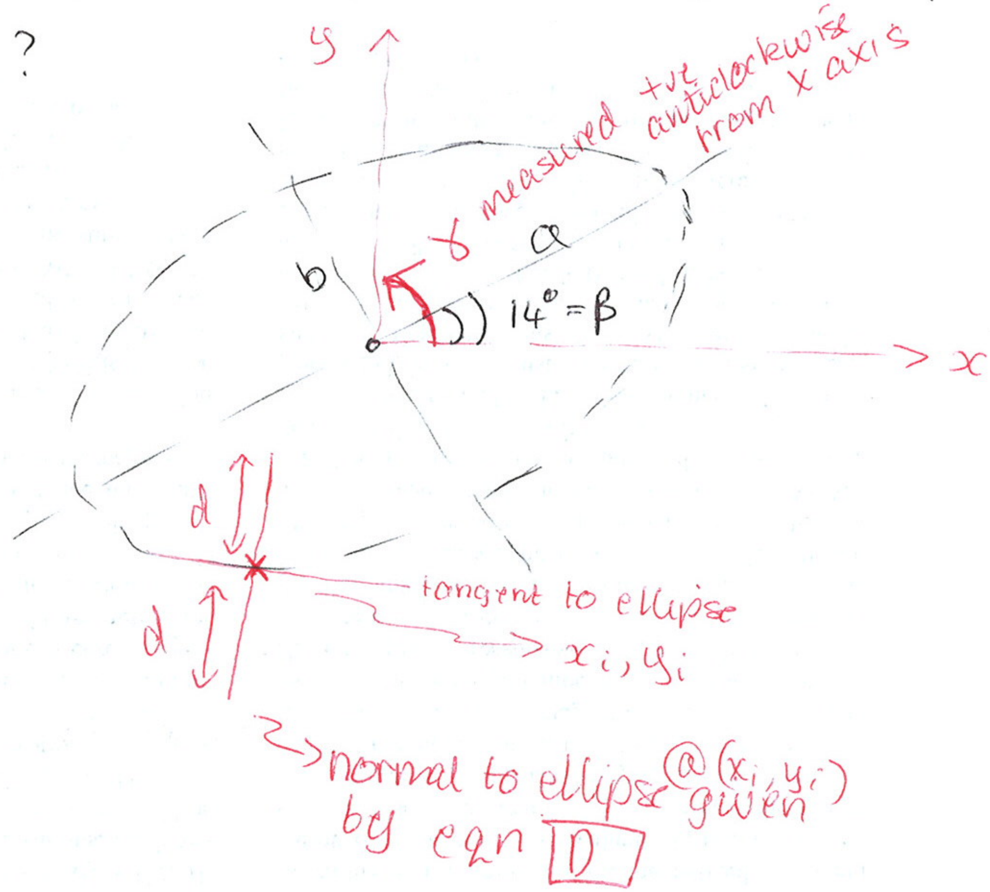
$$y = y_i - \left[\frac{-a_x \sin\gamma_i + b_x \cos\gamma_i}{-a_y \sin\gamma_i + b_y \cos\gamma_i}\right](x - x_i)$$

3) generate x, y coords (still in km) of points ~~normal to the ellipse t~~ along this normal line

3) ctd

that extend a dist $\pm d$ on either side of ellipse

$d \approx 3000$ km ?



not sure how to implement this yet. → want set of x, y points along this normal spaced @ ~ 10km and extending to ~ $\pm d$.

4) Convert ellipse (x, y) points and (x, y) points on each normal line into lat, lon. + move origin to be @ origin of Borealis basin $(67^\circ N, 208^\circ E)$.

$67^\circ N \to \lambda_c$, $208^\circ E \to \phi_c$

~~lat =~~

$$\text{lat}, \lambda = \lambda_c + y\left(\frac{\pi R_{mars}}{180}\right)$$

R_{mars} → radius Mars, use 3393.5 km

if $\lambda > 90^\circ$ means have gone over pole. →

4

eg if $\lambda = 92^\circ$ really @ 88° on other side of pole

& $\varphi = \varphi + 180^\circ$ . . . . .

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longitude 1) $\varphi = \varphi_c + x\left(\frac{\pi R_{mars}}{180}\right) \cdot \cos(\lambda)$

longitude pts spaced more closely @ hi lat.

- check for φ wrapping around 360°
- check whether have to add 180° to φ b/c have gone over pole

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