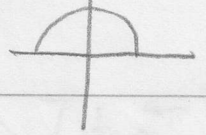


length^2 = $\delta x^2 + \delta y^2$

length = $\sqrt{\delta x^2 + \delta y^2}$

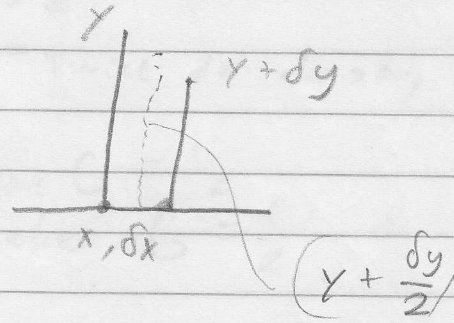
$y = \sqrt{1-x^2}$

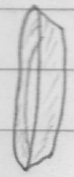
$y = (1-x^2)^{\frac{1}{2}}$

$dy/dx = \frac{1}{2}(1-x^2)^{-1/2} \cdot \frac{d}{dx}(1-x^2)$

$dy/dx = \frac{1}{2}(1-x^2)^{-1/2} \cdot -2x$

$dy/dx = (1-x^2)^{-1/2} \cdot -x$



Area  $= 2\pi\left(y+\frac{\delta y}{2}\right) \cdot \sqrt{\delta x^2 + \delta y^2}$

$= 2\pi\left(y+\frac{\delta y}{2}\right)\sqrt{1+\left(\frac{\delta y}{\delta x}\right)^2} \cdot \delta x$

$= 2\pi \cdot y \cdot \sqrt{1+\left(\frac{dy}{dx}\right)^2} \cdot dx$

$2\pi\sqrt{1-x^2}\sqrt{1+\left(\frac{dy}{dx}\right)^2} \cdot dx$

$2\pi y \cdot \sqrt{1+\left(\frac{x}{y}\right)^2}\, dx$

$2\pi y \sqrt{\frac{y^2+x^2}{y^2}}\, dx$

2π

$\frac{dy}{dx} = -x\left(1-x^2\right)^{-1/2}$

$\left(dy/dx\right)^2 = x^2\left(1-x^2\right)^{-1} = \frac{x^2}{1-x^2}$

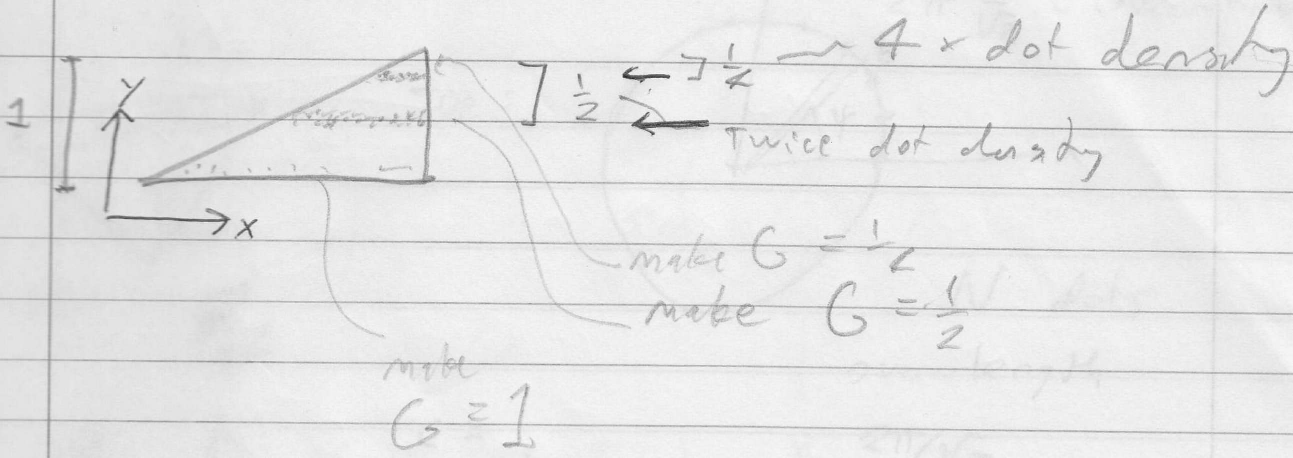
$2\pi\sqrt{1-x^2}\sqrt{1+\frac{x^2}{1-x^2}}\, dx$

$2\pi\sqrt{1-x^2}\sqrt{\frac{1-x^2}{1-x^2}+\frac{x^2}{1-x^2}}\, dx$

$2\pi\sqrt{1-x^2}\sqrt{\frac{1}{1-x^2}}\, dx$

2π

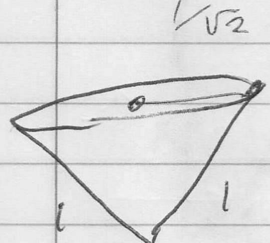
$\int 2\pi\, dx = \boxed{2\pi x}$



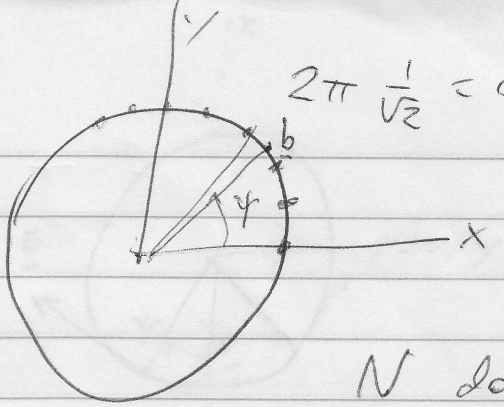
In above triangle, looking at
density of dots along narrow bands
parallel to x-axis

density of dots × $G(y)$ = CONSTANT

so density of dots × 2 $\Rightarrow$ G × $\frac{1}{2}$



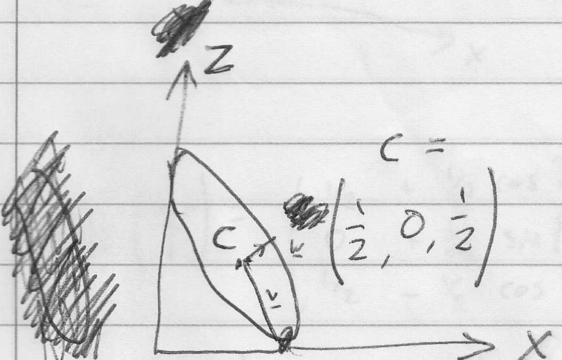
TOP :



$2\pi \frac{1}{\sqrt{2}}$ = circumference

N dots over length $2\pi/\sqrt{2}$

$\therefore$ dots per unit length $= \dfrac{N}{2\pi/\sqrt{2}}$



$$\underline{c} = \begin{pmatrix} \frac{1}{2}, & 0, & \frac{1}{2} \end{pmatrix}$$

$$\underline{v} = \begin{pmatrix} \frac{1}{2} \\ 0 \\ -\frac{1}{2} \end{pmatrix} \quad \underline{w} = \begin{pmatrix} 0 \\ 1/\sqrt{2} \\ 0 \end{pmatrix}$$

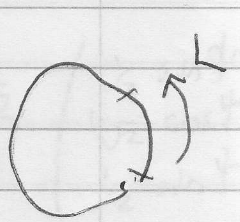
$$\frac{\text{dots in } \Delta L}{\Delta L} = \frac{N}{\pi\sqrt{2}}$$

corresponding to ψ

$$\underline{b}(\psi) = \begin{pmatrix} 1/2 \\ 0 \\ 1/2 \end{pmatrix} + \underline{v}\cos\psi + \underline{w}\sin\psi$$

$$= \begin{pmatrix} 1/2 \\ 0 \\ 1/2 \end{pmatrix} + \cos\psi \cdot \begin{pmatrix} 1/2 \\ 0 \\ -1/2 \end{pmatrix} + \sin\psi \begin{pmatrix} 0 \\ 1/\sqrt{2} \\ 0 \end{pmatrix}$$

$$\underline{b}\big|_z = \frac{1}{2} - \frac{1}{2}\cos\psi$$



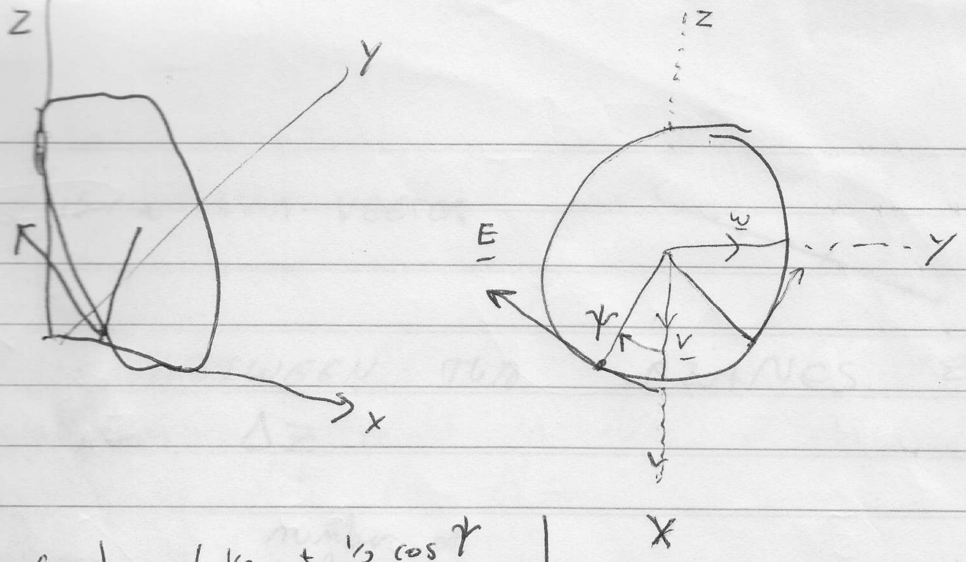
$$\text{dots per } \Delta z = \frac{\text{dots in } \Delta L}{\Delta L} \cdot \frac{\Delta L}{\Delta z}$$

$$\text{dots per } \Delta z = \frac{N}{2\pi/\sqrt{2}} \cdot \frac{\Delta L}{\Delta z} \quad \text{at} \begin{pmatrix} 1/2 \\ -1/\sqrt{2} \\ 1/2 \end{pmatrix}$$

$$\frac{\Delta L}{\Delta z} = \sqrt{2}$$

dots per Δz $=$

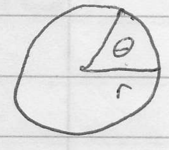
$$\frac{N}{\frac{2\pi}{\sqrt{2}}} \cdot \sqrt{2} = \frac{N}{2\pi} \cdot 2 = N/\pi$$



$$\underline{b}(\psi) = \begin{pmatrix} \tfrac{1}{2} + \tfrac{1}{2}\cos\psi \\ 0 + \tfrac{1}{\sqrt{2}}\sin\psi \\ \tfrac{1}{2} - \tfrac{1}{2}\cos\psi \end{pmatrix}$$

$$\frac{d\underline{b}(\psi)}{\cancel{d\psi}} =$$ No. should differentiate with respect to length

Circle, radius r, angle θ, length of arc traversed = $r\theta$



length of arc
$= r\theta$
$= \frac{1}{\sqrt{2}} \cdot \psi$

$\frac{d\underline{b}}{d(\text{arc length})}$

$$\frac{d\underline{b}(\psi)}{d\left(\frac{1}{\sqrt{2}}\psi\right)} = \sqrt{2}\,\frac{d\underline{b}}{d\psi}$$

$$\frac{d\underline{b}}{d\psi} = \begin{pmatrix} -\tfrac{1}{2}\sin\psi \\ \tfrac{1}{\sqrt{2}}\cos\psi \\ \tfrac{1}{2}\sin\psi \end{pmatrix} \qquad \frac{d\underline{b}}{dl} = \sqrt{2}\begin{pmatrix} -\tfrac{1}{2}\sin\psi \\ \tfrac{1}{\sqrt{2}}\cos\psi \\ \tfrac{1}{2}\sin\psi \end{pmatrix}$$

$$\left|\frac{d\underline{b}}{d\psi}\right|^2 = \frac{1}{4}\sin^2\psi + \frac{1}{2}\cos^2\psi + \frac{1}{4}\sin^2\psi$$

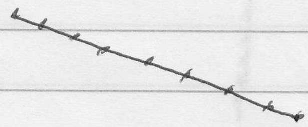
$$= \frac{1}{2}\left(\sin^2 + \cos^2\right)$$

$$= \frac{1}{2}$$

$$\left|\frac{d\underline{b}}{d\psi}\right| = \frac{1}{\sqrt{2}}$$

$$\left|\frac{d\underline{b}}{dl}\right| = 1$$

$\frac{db}{dl}$ IS a UNIT VECTOR

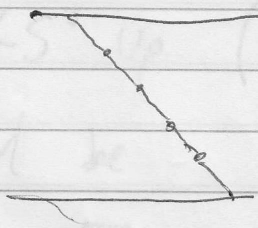


~~For~~ ~~a~~ BETWEEN TWO PLANES z_1, z_2

~~a~~ separation Δz

$$\frac{\Delta z}{\left.\frac{db}{dl}\right|_z} = \text{number of unit vectors in this space}$$

$$\frac{\Delta z}{\frac{\sqrt{2}}{2}\sin\psi}$$



$$\frac{N}{\pi\sqrt{2}} = \text{angular momentum dots per unit length on the circle}$$

$$\frac{\Delta z}{\frac{\sqrt{2}}{2}\sin\psi}\,\frac{N}{\pi\sqrt{2}} = \text{number of dots } \psi, \Delta z$$

$$= \frac{\Delta z}{\sin\psi}\,\frac{N}{\pi}$$

$$= \frac{\Delta z \; N/\pi}{\sqrt{1-\cos^2\psi}}$$

$$= \frac{\Delta z \; N/\pi}{\sqrt{4z - 4z^2}}$$

$$= \frac{\Delta z \; N/\pi}{2\sqrt{z - z^2}}$$

$$\frac{1}{2} - \frac{1}{2}\cos\psi = z$$

$$1 - \cos\psi = 2z$$

$$-\cos\psi = 2z - 1$$

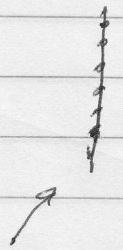
$$\cos\psi = 1 - 2z$$

$$\cos^2\psi = 1 - 4z + 4z^2$$

when $z = \frac{1}{2}$:

$$= \frac{\Delta z \; N/\pi}{2\sqrt{\frac{1}{4}}} = \Delta z\,\frac{N}{\pi}$$

$\frac{N}{\pi\sqrt{2}}$ = number of DOTS per unit length on circle.

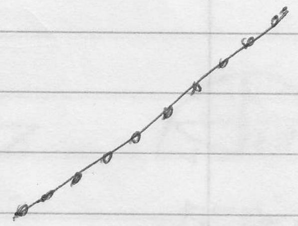


IF we stretch circle into a line going straight up along Z-AXIS number of dots in ΔZ is $\Delta z \cdot \frac{N}{\pi\sqrt{2}}$

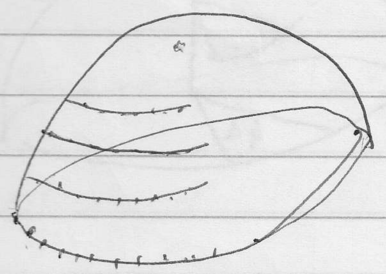
And if this line is 45° up (45° to z axis.) number of dots in ΔZ should be

$$\Delta Z \cdot \frac{N}{\pi\sqrt{2}} \times \sqrt{2}$$

$$= \Delta z \cdot \frac{N}{\pi}$$



CONFIRMS RESULT



at base of CONE DOME,

RADIUS = 1

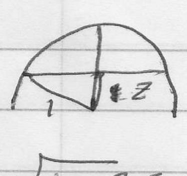
CIRCUMFERENCE = 2π

NUMBER OF POINTS = M $\quad \frac{M}{2\pi}$ = points per unit length

FOR EACH LATITUDINAL CIRCLE
NUMBER OF POINTS = M

FOR LATITUDINAL CIRCLE, height Z

$2\pi\sqrt{1-Z^2}$ = circumference

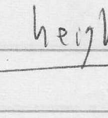


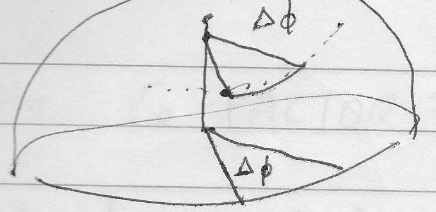
$\sqrt{1-z^2}$ = radius

Number of points per unit length around latitudinal circle $= \dfrac{M}{2\pi\sqrt{1-Z^2}}$

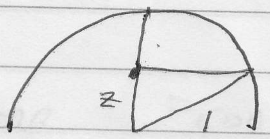
IN LONGITUDINAL REGION, $\Delta\phi$ THE

Number of planes on CONE DOME, from height Z to $Z+\Delta Z$ $= \dfrac{\Delta Z \; N/\pi}{2\sqrt{Z-Z^2}}$





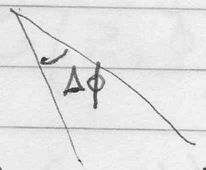
Arc length

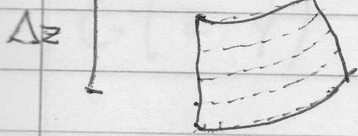


$$\text{Arc length} = \sqrt{1-z^2}\cdot\Delta\phi$$

$$\text{Number of points} = \sqrt{1-z^2}\cdot\Delta\phi\cdot\frac{M}{2\pi\sqrt{1-z^2}}$$

$$= \frac{\Delta\phi}{2\pi}M$$





region, from z to $z+\Delta z$, $\Delta\phi$

number of points =

number of planes × number of points in each plane

$$= \frac{\Delta z \quad N/\pi}{2\sqrt{z-z^2}}\cdot\frac{\Delta\phi}{2\pi}M$$

$$= (\Delta z\,\Delta\phi)(N\,M)\left(\frac{1}{4\pi^2\sqrt{z-z^2}}\right)$$

$$\text{surface area} = 2\pi\cdot\Delta z\cdot\frac{\Delta\phi}{2\pi} = \Delta z\,\Delta\phi$$

the G-FACTOR:

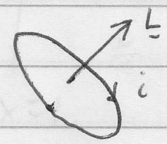
Density of Points × G FACTOR = const = α

$$G = \frac{\alpha}{\text{Density of Points}}$$

$$G(z, \phi) = \frac{\alpha}{NM \frac{1}{4\pi^2} \frac{1}{\sqrt{z - z^2}}}$$

$$G(z, \phi) = \alpha' \sqrt{z - z^2}$$

the G FACTOR MULTIPLIES the ANGULAR MOMENTUM associated with the corresponding Great Circle



Hence, if Great Circle has charge q of mass m making current i (~~q~~ i measured in e.g. nanoamperes)

then $q \rightrightarrows Gq$

$m \rightrightarrows Gm$

and $i \rightrightarrows Gi$

so $L \rightrightarrows GL$

But does this REALLY lead to a uniform charge density, as Dr. Mills states ~~an~~ is shown numerically in ~~pp 83-8~~ Chapter 1 of GUT-CP

$$y = \sqrt{x - x^2}$$

$$y^2 = x - x^2$$

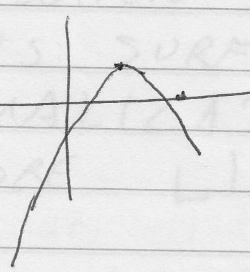
$$= -x^2 + x$$

$$= -(x^2 - x)$$

$$y = -\left[\left(x - \tfrac{1}{2}\right)^2 - \tfrac{1}{4}\right]$$

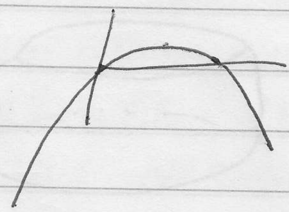
$$= -\left(x - \tfrac{1}{2}\right)^2 + \tfrac{1}{4}$$

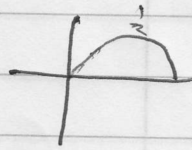
$\left(\tfrac{1}{2}, \tfrac{1}{4}\right)$

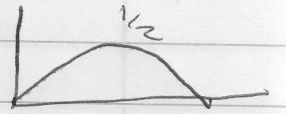


$$0 = -(x^2 - x)$$

$$y = x(1 - x)$$



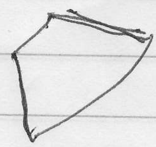




$$\frac{dy}{dx} = 1 - 2x$$

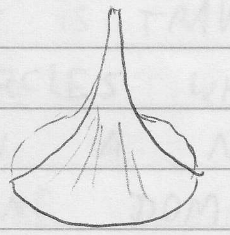
$$\left.\frac{dy}{dx}\right|_{x=0} = 1$$

$$\left.\frac{dy}{dx}\right|_{x=1} = -1$$

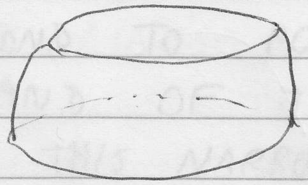


Question:
IF density of PLANES on the Cone Dome were CONSTANT, what would we then have?

IN ANSWER TO QUESTION POSED EARLIER, WHICH WAS "DOES THE CONE DOME, WHEN EACH VECTOR ENDING ON ITS SURFACE IS MULTIPLIED BY NORMALIZATION FACTOR BECOME MORE LIKE

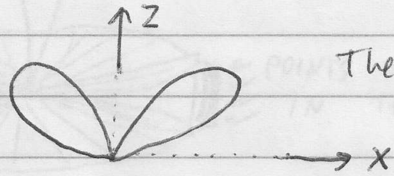


OR



?"

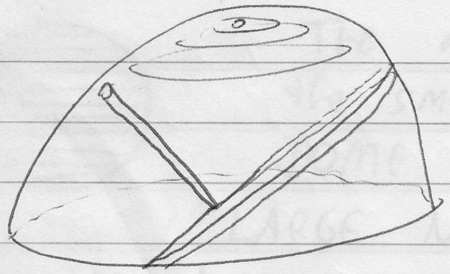
ACTUALLY IT BECOMES MORE LIKE THIS



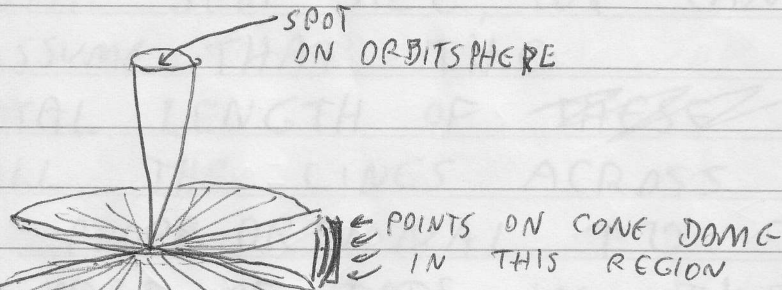
The PETALS, RESIDUE ROTATED ABOUT +Z AXIS

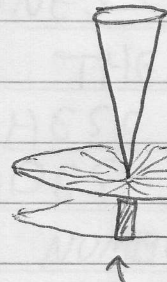
The "PETAL CUP"

ORBITSPHERE
& CONE DOME
SUPERPOSED

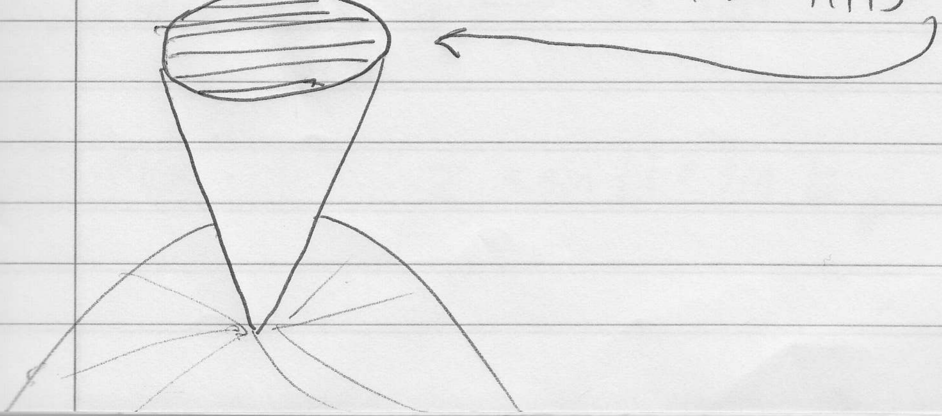


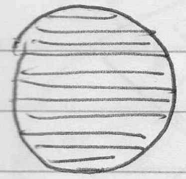
CONSIDER A SMALL CIRCULAR SPOT ON THE ORBITSPHERE
IT IS TRAVERSED BY PIECES OF GREAT
CIRCLES WHICH CORRESPOND TO POINTS
ON A NARROW BAND OF THE
CONE DOME. CALL THIS NARROW BAND
THE "HANDLE"





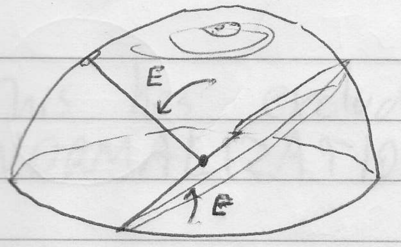
POINTS
ON THIS
REGION CAUSE
LINES
ACROSS SPOT
LIKE THIS



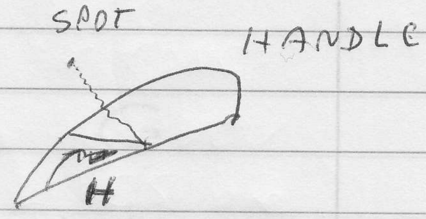


The density of points on the small region of the CONE DOME is such that a VERY LARGE NUMBER OF LINES are DRAWN ACROSS THE SPOT.
THIS IS EVEN THOUGH THE ~~BECAUSE~~ SPOT ITSELF IS SMALL.

SINCE THE NUMBERS OF LINES ACROSS THE SPOT ARE LARGE SO THAT LINE SEPARATION IS SMALL COMPARED WITH SPOT SIZE, WE CAN ASSUME THAT THE TOTAL LENGTH OF ~~THESE CROSSING LINES~~ ALL THE LINES ACROSS THE SPOT IS PROPORTIONAL TO THE NUMBER OF DOTS IN THE SMALL SECTION OF THE CONE DOME THAT WE ARE DRAWING THESE CROSS LINES FROM.
THE RELATIVE ORIENTATION OF THESE DOTS IN THE CONE DOME DOES NOT MATTER, SINCE THE NUMBERS OF DOTS AND CORRESPONDING ARE SO LARGE

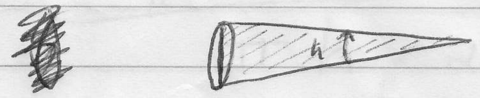


radius $=1$



ASSUME THE NARROW BAND IS SO narrow that we can treat it like a piece of cylinder, profile radius $= 1$
height h

h is determined by the spot size



h radians = angle (NOT SOLID ANGLE) subtended by spot size

TOTAL CHARGE IN THE SPOT $= Q_{TOTAL}$

$$Q_{TOTAL} \propto \int_{H=0}^{H=\pi} \text{density of points on cone dome} \cdot h \cdot dH$$

FROM EARLIER, density of points on Cone Dome $= NM \dfrac{1}{4\pi^2\sqrt{z-z^2}}$

$$= \frac{\gamma}{\sqrt{z-z^2}}$$

$\gamma = \text{constant}$

$$Q_{TOTAL} \propto \int_{H=0}^{H=\pi} \frac{\gamma}{\sqrt{z-z^2}} \cdot h \cdot dH$$

$$z = \sin H \cdot \sin E$$

This has excluded the NORMALIZATION FACTOR, G

FROM EARLIER, $G = \alpha' \sqrt{z - z^2}$.

if we multiply DOT DENSITY by G we get

$$Q \propto \int_0^{\pi} \frac{\gamma}{\sqrt{z - z^2}} \, h \, \alpha' \sqrt{z - z^2} \, dH$$

$$= \int_0^{\pi} \gamma \alpha' h \, dH$$

$$\boxed{Q = \pi h \gamma \alpha'}$$

= CONSTANT WITH RESPECT TO SPOT LOCATION POLAR ANGLE E.