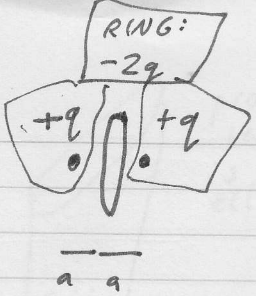
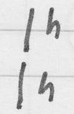
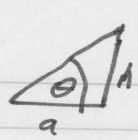
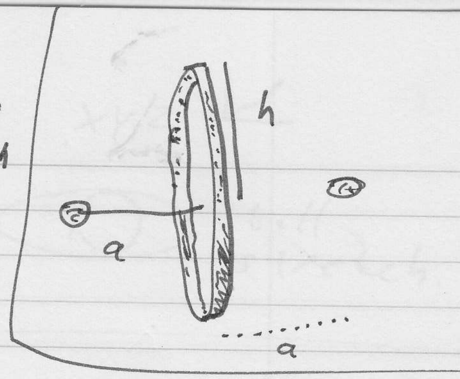








q $\bullet\!\!\rightarrow$ FORCE TOWARDS CENTRE OF RING

$$= (-1)\,\frac{k\,(q)(-2q)}{\left(\sqrt{a^2+h^2}\right)^2}\cdot\cos\theta \qquad \cos\theta = \frac{a}{\sqrt{a^2+h^2}}$$

$$F = \frac{2kq^2\cdot a}{(a^2+h^2)^{3/2}}$$

$\leftarrow\!\!\bullet$ Force due to other positive charge q

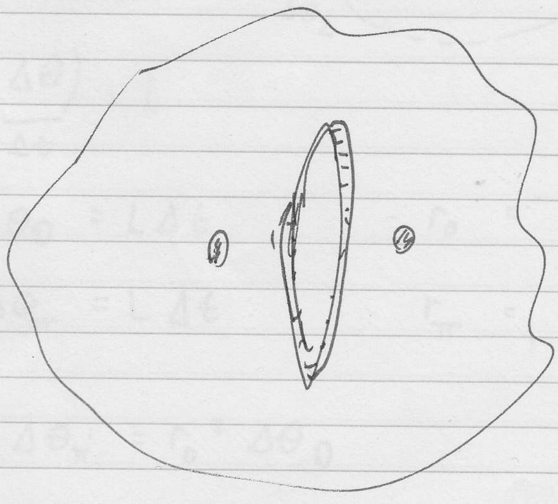
$$= \frac{kq^2}{(2a)^2} = \frac{kq^2}{4a^2}$$

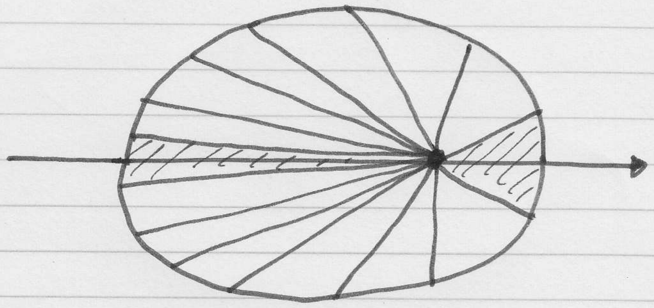
Equilibrium when $\quad \dfrac{2kq^2a}{(a^2+h^2)^{3/2}} = \dfrac{kq^2}{4a^2}$

$$\frac{2a}{(a^2+h^2)^{3/2}} = \frac{1}{4a^2}$$

$$\frac{8a^3}{(a^2+h^2)^{3/2}} = 1$$

$$8a^3 = (a^2+h^2)^{3/2}$$





KEPLERS LAW OF AREAS

SECTIONS OF EQUAL AREAS ARE TRAVERSED IN EQUAL TIMES.

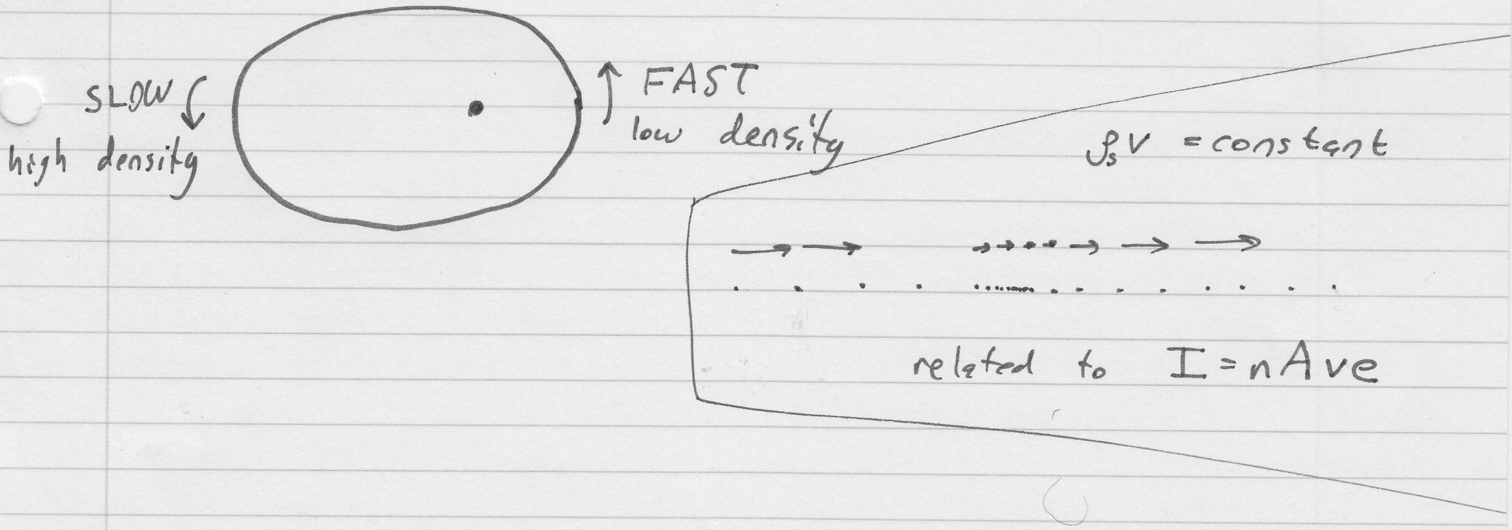
CONSTANT CURRENT AROUND ELLIPSE.

AT A POINT, $V\rho_s = I$ = CONSTANT CURRENT

ρ_s = DENSITY OF ~~CH~~ CHARGE ALONG ELLIPTIC ARC

$$= \lim_{\delta s \to 0} \frac{\delta Q}{\delta s}$$

δs = arclength



WHAT IS VELOCITY AT A POINT ON ELLIPSE?

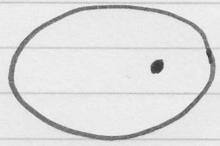
FROM *FOWLES* REFERENCE (7th Edition p230)

$$m(\dot{r}\theta + r\ddot{\theta}) = 0$$

$$\frac{d}{dt}(r^2\theta) = 0 \qquad r^2\dot{\theta} = L$$

$$r = \frac{1}{u} \qquad \dot{r} = \frac{-1}{u^2}\dot{u} = \frac{-1}{u^2}\dot{\theta}\frac{du}{d\theta} = -L\frac{du}{d\theta}$$

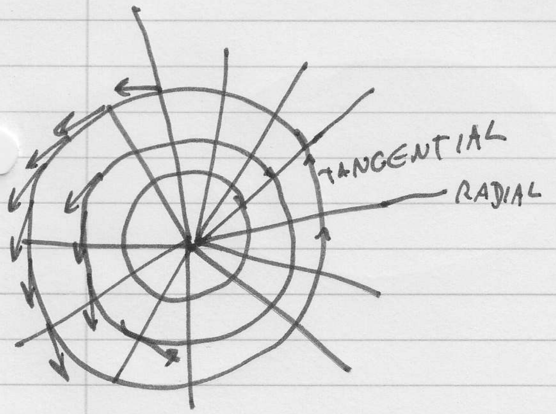
ELLIPTIC ORBIT



$$r = \frac{1}{1 + A\cos\theta}$$

$$\frac{1}{r} = 1 + A\cos\theta$$

$$\frac{du}{d\theta} = \frac{d}{d\theta}\left(\frac{1}{r}\right) = -A\sin\theta$$



$$v^2 = V_{Tangential}^2 + V_{Radial}^2$$

$$V_{Tangential} = r\dot{\theta} = \frac{L}{r}$$

$$V_{RADIAL} = LA\sin\theta$$

$$v^2 = \frac{L^2}{r^2} + L^2A^2\sin^2\theta$$

$$v = \left[\frac{L^2}{r^2} + L^2A^2\sin^2\theta\right]^{1/2}$$

$$v = L^{2\cdot\frac{1}{2}}\left(\frac{1}{r^2} + A^2\sin^2\theta\right)^{1/2}$$

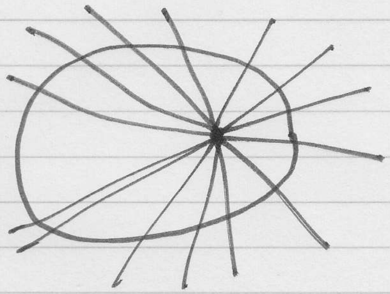
$$v = L\left[(1 + A\cos\theta)^2 + A^2\sin^2\theta\right]^{1/2}$$

$$v = L\left[1 + 2A\cos\theta + A^2\right]^{1/2}$$

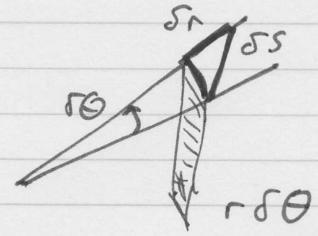
Then from $v \rho_s = I$, $\rho_s = I/v$

$$\rho_s = I L^{-1} \left[1 + 2A\cos\theta + A^2 \right]^{-1/2}$$

ARCLENGTH :



TO GO FROM θ to $\theta + \delta\theta$:



$$\delta s^2 = (r\,\delta\theta)^2 + \delta r^2$$

$$\left(\frac{\delta s}{\delta\theta}\right)^2 = r^2 + \left(\frac{\delta r}{\delta\theta}\right)^2$$

$$\left(\frac{ds}{d\theta}\right)^2 = r^2 + \left(\frac{dr}{d\theta}\right)^2$$

$$\frac{ds}{d\theta} = \left[r^2 + \left(\frac{dr}{d\theta}\right)^2 \right]^{1/2}$$

$$r = \frac{1}{1 + A\cos\theta}$$

$$\frac{dr}{d\theta} = (-1)(1 + A\cos\theta)^{-2}(-A\sin\theta) = \frac{A\sin\theta}{(1 + A\cos\theta)^2}$$

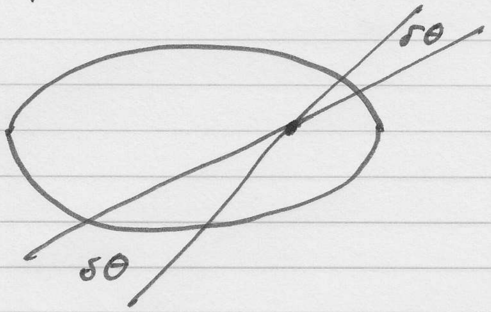
$$\left(\frac{dr}{d\theta}\right)^2 = \frac{A^2 \sin^2\theta}{(1 + A\cos\theta)^4}$$

$$\frac{ds}{d\theta} = \left[\frac{(1 + A\cos\theta)^2}{(1 + A\cos\theta)^4} + \frac{A^2\sin^2\theta}{(1 + A\cos\theta)^4} \right]^{1/2}$$

$$= \frac{(1 + 2A\cos\theta + A^2)^{1/2}}{(1 + A\cos\theta)^2}$$

$$\frac{ds}{d\theta} = (1 + 2A\cos\theta + A^2)^{1/2} \cdot r^2$$

SO, for a PIECE OF ELLIPTIC ARC



GIVEN BY

$\delta\theta$,

TOTAL CHARGE ON THAT PIECE OF ARC

$$= \rho_s \cdot \delta s$$

$$= I L^{-1} (1 + 2A\cos\theta + A^2)^{-1/2} \cdot (1 + 2A\cos\theta + A^2)^{1/2} \cdot r^2 \, \delta\theta$$

$$= I L^{-1} r^2 \, \delta\theta$$

SO, IT IS PROPORTIONAL TO r^2.

FORCE ON NUCLEUS AT FOCUS

$$\propto k \cdot (\rho_s \cdot \delta s) \cdot \frac{1}{r^2}$$

INVERSE SQUARE.

Therefore, FORCE ON NUCLEUS FROM PIECE OF ELLIPSE AT $\delta\theta$ IS CANCELLED OUT BY EQUAL FORCE FROM PIECE OF ELLIPSE $\delta\theta$ ON OPPOSITE SIDE.

∴ NUCLEUS AT FOCUS OF ELLIPTIC FILAMENT OF CIRCULATING NEGATIVE CHARGE EXPERIENCES NO NET FORCE.