Langat Singh College, Muzaffarpur
NAAC Grade 'A'
Under B. R. A. Bihar University, Muzaffarpur

Motion of charged particles –L - 05

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Time Varying B Field (E inductive

Particle can gain energy from the inductive E field

$$\nabla \wedge \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \quad (66)$$

$$\text{or} \oint \mathbf{E}.\mathbf{dl} = -\int_s \dot{\mathbf{B}}.\mathbf{ds} = -\frac{d\Phi}{dt} \quad (67)$$

Hence work done on particle in 1 revolution is

$$\delta w = -\oint |q|\mathbf{E}.\mathbf{d}\ell = +|q|\int_s \dot{\mathbf{B}}.\mathbf{ds} = +|q|\frac{d\Phi}{dt} = |q|\dot{B}\pi r_L^2 \quad (68)$$

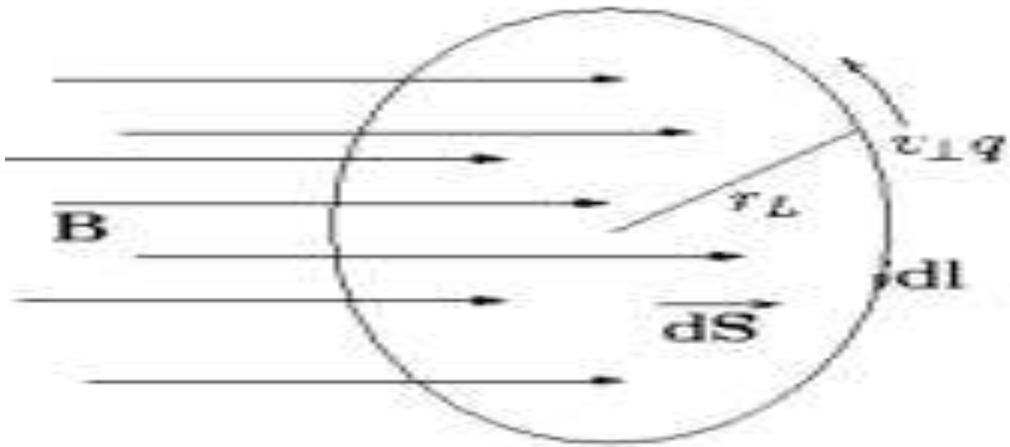

Figure 11. Particle orbits round B so as to perform a line integral of the

Electric field

(d and v⊥q are in opposition directions).

$$\delta\left(\frac{1}{2}mv_\perp^2\right) = |q|\dot{B}\pi r_L^2 = \frac{2\pi\dot{B}m}{|q|B}\frac{\frac{1}{2}mv_\perp^2}{B} \qquad (69)$$

$$= \frac{2\pi B}{|\Omega|}\mu. \qquad (70)$$

Hence

$$\frac{d}{dt}\left(\frac{1}{2}mv_\perp^2\right) = \frac{|\Omega|}{2\pi}\delta\left(\frac{1}{2}mv_\perp^2\right) = \mu\frac{db}{dt} \tag{71}$$

but also

$$\frac{d}{dt}\left(\frac{1}{2}mv_\perp^2\right) = \frac{d}{dt}(\mu B) \tag{72}$$

Hence

$$\frac{d\mu}{dt} = 0. \tag{73}$$

Since Φ is just another way of saying that the flux through the gyro q_2 orbit is conserved.

Notice also energy increase. Method of ‘heating’. Adiabatic Compression.