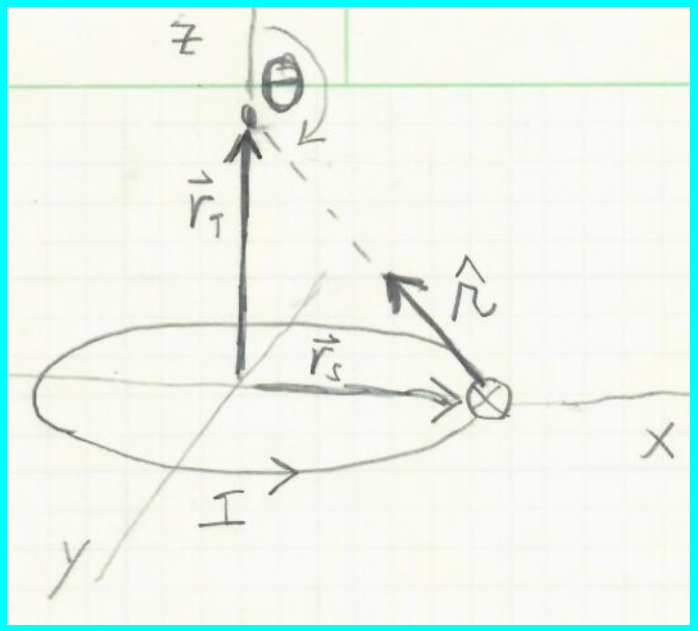
Lecture 35 outline: 11/09/2020

- Biot Savart
- Result for Helmholtz coil
- Applied to current ring.
- Field of a solenoid

Cyclotron motion in Helmholz Coil (RS 8-09)



$$B_z = \frac{\mu_0 I}{2} \frac{b^2}{(a^2+b^2)^{3/2}}$$

Biot-Savart Law (RS 8-08)

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\int \frac{\rho\hat{\mathcal{r}}}{\mathcal{r}^2}\,d\tau$$

$$\vec{B} = \frac{\mu_0}{4\pi}\int \frac{I\,d\vec{l}\times\hat{\mathcal{r}}}{\mathcal{r}^2}$$

Current Ring

$$\vec{B} = \frac{\mu_0}{4\pi} \int \frac{I\, d\vec{l} \times \hat{\mathcal{r}}}{\mathcal{r}^2}$$

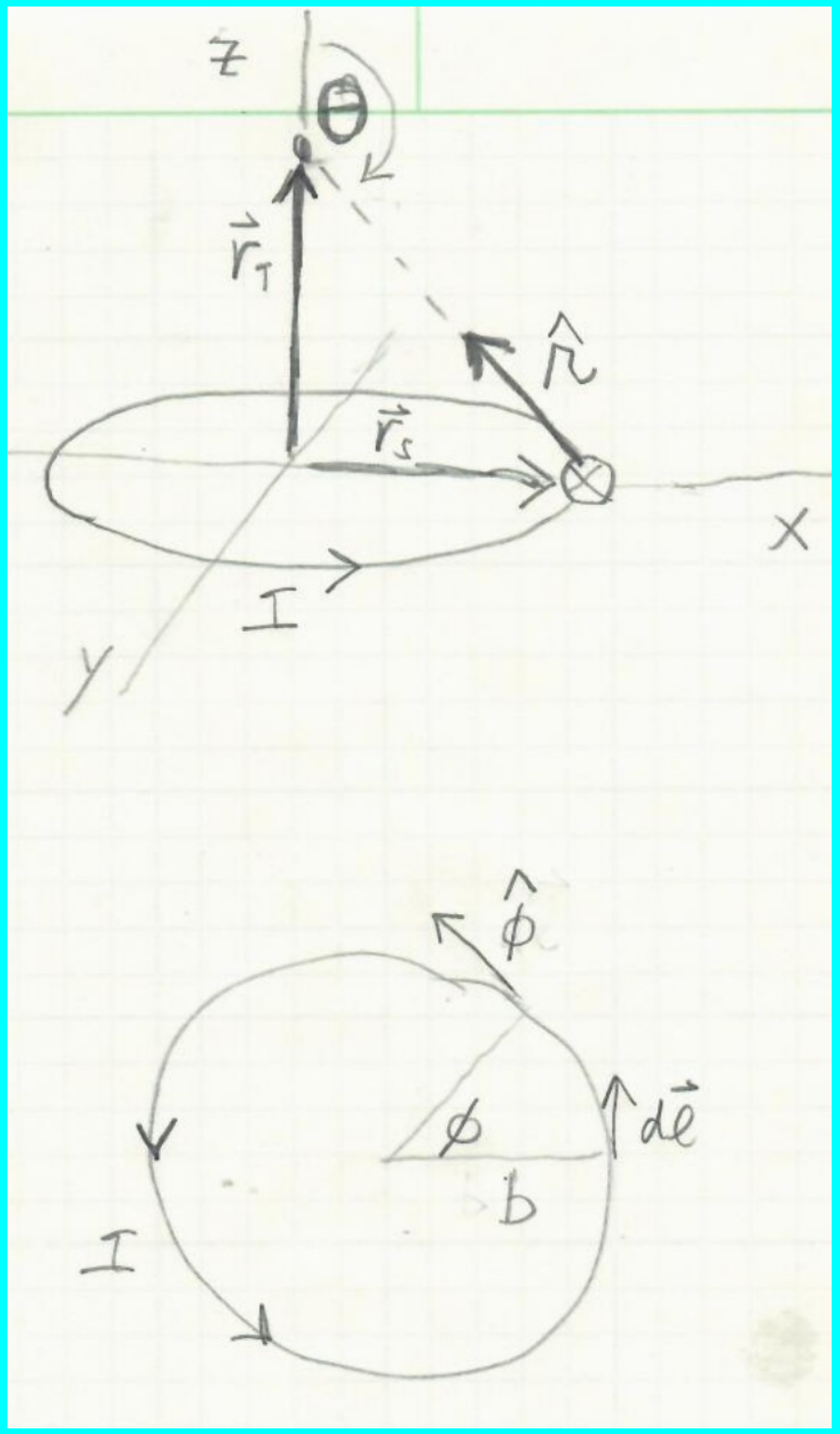
$$\vec{r}_T = a\,\hat{z}$$

$$\vec{r}_S = b\,\hat{r}$$

$$\hat{r} = \cos\phi\,\hat{x} + \sin\phi\,\hat{y}$$

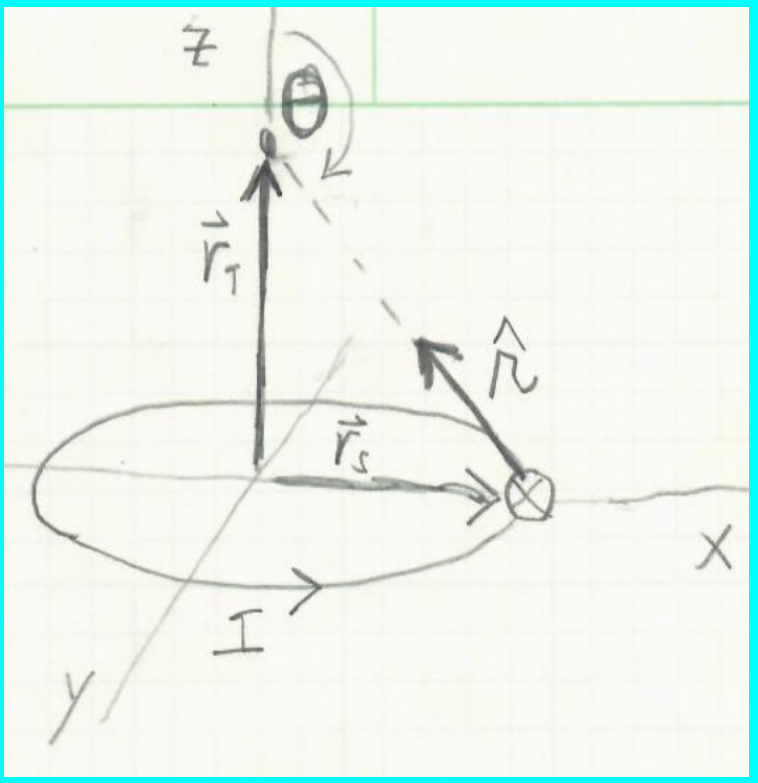
$$d\vec{l} = b\,d\phi\,\hat{\phi}$$

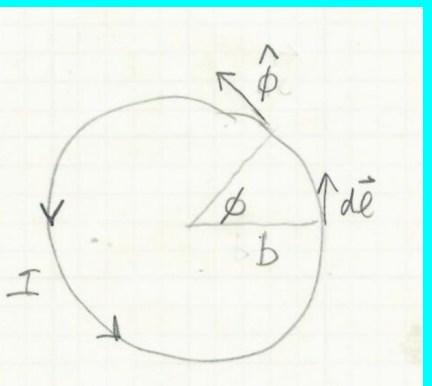
$$\hat{\phi} = -\sin\phi\,\hat{x} + \cos\phi\,\hat{y}$$



Current Ring

$$\vec{B} = \frac{\mu_0}{4\pi} \int \frac{I\, d\vec{l} \times \hat{r}}{r^2}$$





Solenoid

No circumferential component (no current enclosed)

No radial component (that would give a divergence)

Bz=0 outside (Because B is zero at infinity)

No free parameters for radial variation of Bz

Solenoid $\vec{B} = \pm \mu_0 n I \hat{z}$