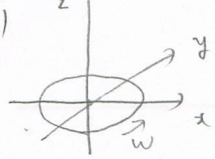
(1)



$\vec{L} = \vec{r} \times \vec{p}$

$\vec{r} \perp \vec{p}$, $\vec{r} \times \vec{p} \parallel \vec{e}_z$ より

$|\vec{L}| = |\vec{r}| \times |\vec{p}|$

$= a \times ma\omega$

$= ma^2\omega$

(2)

$I = \frac{q}{2\pi a} \cdot a\omega$

$= \frac{q\omega}{2\pi}$

$A = \pi a^2$

$\therefore |\vec{M}| = IA = \frac{qa^2\omega}{2}$

(3)

$\chi = \frac{M}{L} = \frac{\frac{qa^2\omega}{2}}{ma^2\omega} = \frac{q}{2m}$

(4)

$\vec{N} = \vec{M} \times \vec{B}$

$= \frac{qa^2\omega}{2} \begin{pmatrix} \sin\theta\cos\varphi \\ \sin\theta\sin\varphi \\ \cos\theta \end{pmatrix} \times \begin{pmatrix} 0 \\ 0 \\ B \end{pmatrix}$

$= \frac{qa^2\omega}{2} \begin{pmatrix} B\sin\theta\sin\varphi \\ -B\sin\theta\cos\varphi \\ 0 \end{pmatrix}$

$\vec{L} = I\omega\vec{r}$

$= ma^2\omega \begin{pmatrix} \sin\theta\cos\varphi \\ \sin\theta\sin\varphi \\ \cos\theta \end{pmatrix}$

$\frac{d\vec{L}}{dt} = \vec{N}$

・z成分 $\frac{dL_z}{dt} = N_z = 0 \rightarrow \theta = \text{const.}$

・x成分 $\frac{dL_x}{dt} = N_x$

$\rightarrow -ma^2\omega\sin\theta\sin\varphi \cdot \dot{\varphi} = \frac{qa^2\omega}{2} \cdot B\sin\theta\sin\varphi$

$\dot{\varphi} = -\frac{qB}{2m}$

$\therefore \Omega = \frac{qB}{2m}$