HW4 of Plasma

Chen Zang.

1. according to $r_g = \frac{m \cdot |v|}{qB}$ $(v_\parallel = 0)$.

(1) $r_g = \sqrt{2Em_e}/qB = 5.328 \times 10^{10}$ m

(2) $r_g = m_p v / qB = 3.132 \times 10^{6}$ m

(3) $r_g = \sqrt{2M_H \cdot E}/qB = 9.588 \times 10^{-3}$ m

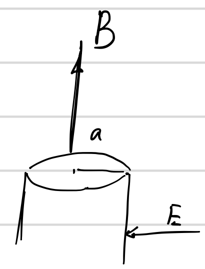
(4) $r_g = \sqrt{2M_H \cdot E}/qB = 3.368 \times 10^{-2}$ m

2. Lamor radius with 200 keV energy,

$r_g = \sqrt{2M_D \cdot E}/e \cdot B$, apply $B = 5T$

$r_g = 1.83 \times 10^{-2}$ m $< a$

the deuterium confinement is satisfied.



3. at surface of $r=a$, electric field E is:

$\vec{E} = -\hat{e}_r \cdot \frac{\lambda}{2\pi\varepsilon_0 \cdot a}$, with $\lambda = \pi a^2 \cdot e \cdot n_e$.

so E×B drift $\vec{v}_E$ is:

$$\vec{v}_E = \frac{\vec{E} \times \vec{B}}{|B|^2} = -\frac{E}{B}\hat{e}_\theta \quad \text{(clockwise)}$$

so $\vec{v}_E = -\frac{a \cdot e n_e}{2\varepsilon_0 \cdot B}\hat{e}_\theta = 4.524$ km $(-\hat{e}_\theta)$

4. $E_B = B^2/8\pi$, $E_m = n_e m_e c^2$.

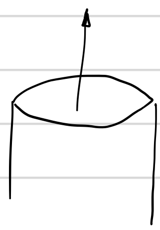
and $\Omega_{ce} = eB/m_e c$, $\omega_{pe} = \sqrt{4\pi n_e \cdot e^2/m_e}$

$$\frac{\Omega_{ce}}{\omega_{pe}} = \sqrt{\left(\frac{eB}{m_e c}\right)^2 \cdot \frac{m_e}{4\pi n_e e^2}} = \sqrt{\frac{B^2}{4\pi} \cdot \frac{1}{n_e \cdot m_e c^2}} = \sqrt{\frac{2E_B}{E_m}}$$

5. reletivistic particle still satisfied:

$$q \cdot v_\perp B = \gamma m \cdot \frac{v_\perp^2}{r}, \text{ so } r_g = \frac{\gamma m \cdot v_\perp}{qB}$$

$$r_g = \frac{\gamma \cdot m \cdot v \cdot \sin\alpha}{qB}. \qquad \omega = \frac{q \cdot B}{\gamma \cdot m}$$



6. (a) $\vec{\omega}_0 \times \vec{r} = c \vec{E} \times \vec{B} / |B|^2$

so $\vec{E} = -\frac{\omega_0 B}{c} r \cdot \hat{e}_r$

(b), $\nabla \cdot \vec{E} = \frac{1}{r} \cdot \partial_r (r \cdot E_r) = -\frac{2\omega_0 B}{c}$

so $\rho_q = -\frac{\omega_0 B}{2\pi c}$ which is independent from radius.

(c), $\varphi = -\int E \cdot dr = \frac{\omega_0 B}{2c} \cdot r^2 + C$ (inside plasma)