$\tilde{B} = \begin{pmatrix} B_x \\ B_y \\ B_z \end{pmatrix}$ $\quad D_0 \hat{z} \times$ $\quad - J_0 \tilde{B}_y$ $\quad J_0 \tilde{B}_x$ $\quad 0$

$\boxed{\text{Zach Day 1 Q3 (Waves)}}$

$$\frac{e v B}{c} = \frac{m v^2}{r} = m v \Omega$$

$$\Omega = \frac{v}{r} \qquad \Omega = \frac{e B}{m c}$$

$$n = n_0 + \tilde{n}$$

cold fluid eq.

$$E_0 = 0$$

$$J = \Sigma (e n v)_s \qquad B_0 = B_0 \hat{z}$$

$$n_s \frac{dv_s}{dt} = \frac{n_s q_s}{m_s}\left(E + \frac{v \times B}{c}\right) \qquad v_e = v_d \hat{z} + \tilde{v} \qquad \text{ions uncharged.}$$

e^- :

$$n_e\left(\frac{\partial \tilde{v}}{\partial t} + v_d \cdot \nabla \tilde{v}\right) = -\frac{n_e e}{m_e}\left(\tilde{E} + \frac{(v_d \hat{z} + \tilde{v}) \times (B_0 \hat{z} + \tilde{B})}{c}\right)$$

$$n_e\left(\dot{\tilde{v}} + v_d \frac{\partial \tilde{v}}{\partial z}\right) = -\frac{n_e e \tilde{E}}{m_e}$$

$$m n_0\left(\dot{\tilde{v}} + v_d \frac{\partial \tilde{v}}{\partial z}\right) = -\frac{n_0 e \tilde{E}}{m} + \frac{(J_0 \hat{z} + \tilde{J}) \times (B_0 \hat{z} + \tilde{B})}{c}$$

$$+ \frac{J_0 \hat{z} \times \tilde{B}}{c} + \frac{\tilde{J} \times B_0 \hat{z}}{c}$$

$$= -n_0 e \tilde{E} \quad \frac{J_0}{c}\begin{pmatrix} -\tilde{B}_y \\ \tilde{B}_x \end{pmatrix} + \frac{B_0}{c}\begin{pmatrix} \tilde{J}_y \\ -\tilde{J}_x \end{pmatrix}$$

FT : $\nabla \to i k_y \quad \partial_t \to -i\omega$

$$\hat{f}(k, \omega) = \int e^{i(\omega t - kx)} \, dx \, dt \, f(x, t)$$

$$\dot{\tilde{J}} + J_0 \frac{\partial \tilde{v}}{\partial z} = \frac{n_0 e^2}{m} \tilde{E} - \frac{e J_0}{mc} \tilde{B} - \frac{e B_0}{mc}$$

$$\begin{pmatrix} \dot{\tilde{J}}_x \\ \dot{\tilde{J}}_y \end{pmatrix} + J_0 \, \partial_z \begin{pmatrix} \tilde{v}_x \\ \tilde{v}_y \end{pmatrix} = \frac{\omega_{pe}^2}{4\pi} \tilde{E} - \frac{e J_0}{mc}\begin{pmatrix} -\tilde{B}_y \\ \tilde{B}_x \end{pmatrix} - \frac{e B_0}{mc}\begin{pmatrix} \tilde{J}_y \\ -\tilde{J}_x \end{pmatrix}$$

$$- \frac{J_0 \, \partial_z}{e n_0}\begin{pmatrix} \tilde{J}_x \\ \tilde{J}_y \end{pmatrix}$$

$$\left(-i\omega - \frac{i k_z J_0}{e n_0}\right) \tilde{J}_\perp = \frac{\omega_{pe}^2}{4\pi} \tilde{E} - \frac{e J_0}{mc}\begin{pmatrix} -\tilde{B}_y \\ \tilde{B}_x \end{pmatrix} - \Omega \begin{pmatrix} \tilde{J}_y \\ -\tilde{J}_x \end{pmatrix}$$

$$\tilde{J}_x = i(\omega - V_D k_z)^{-1}\left[\frac{\omega_{pe}^2}{4\pi} \tilde{E}_x + \frac{e J_0}{mc} \tilde{B}_y - \Omega \tilde{J}_y\right]$$

$$-i(\,)\tilde{J}_x + \Omega \tilde{J}_y = (\,)\tilde{E}_x + (\,)\tilde{B}_y$$

$$-i(\,)\tilde{J}_y \mp \Omega \tilde{J}_x = (\,)\tilde{E}_y - (\,)\tilde{B}_x$$

$$A x + B y \to \cancel{A^2 x + AB y} \quad BA x + B^2 y \quad \text{or} \quad A^2 x + AB y$$

$$-B x + A y \qquad -AB x + A^2 y \qquad -B^2 x + A^2 y$$

$$A^2 x + AB y$$

$$-B^2 x + AB y$$

Ω not carrying sign here. $\quad \Omega = \frac{eB_0}{mc}$

$\alpha = \frac{eJ_0}{mc}$

$\boxed{\text{Form Phy 1 Q3 (waves)}}$

$$-i(\omega - V_D k_z)\Omega \tilde{J}_x + \Omega^2 \tilde{J}_y$$
$$-(\omega - V_D k_z)^2 \tilde{J}_y + i(\ )\Omega \tilde{J}_x$$

$$[\Omega^2 - (\omega - V_D k_z)^2]\tilde{J}_y = \cancel{\frac{\omega_p^2}{4\pi}} \cancel{\alpha\Omega}$$
$$= \frac{\omega_p^2}{4\pi}\left[\Omega \tilde{E}_x - i(\omega - V_D k_z)\tilde{E}_y\right]$$
$$+ \alpha\left[\Omega \tilde{B}_y + i(\omega - V_D k_z)\tilde{B}_x\right]$$
$$= \cancel{\frac{\omega_p^2}{4\pi}}\begin{pmatrix} \Omega & \\ & -i(\omega - V_D k_z)\end{pmatrix}\frac{\omega_p^2}{4\pi}\begin{pmatrix}\tilde{E}_x \\ \tilde{E}_y\end{pmatrix} + \alpha\begin{pmatrix} B_y \\ -B_x\end{pmatrix}$$

$$-(\omega - V_D k_z)^2 \tilde{J}_x - i(\ )\Omega \tilde{J}_y$$
$$-\Omega^2 \tilde{J}_x \quad - i\Omega(\ )\tilde{J}_y$$

$$-(\omega - V_D k_z)^2 + \Omega^2 x = \begin{pmatrix} -i(\omega - V_D k_z) & \\ & -\Omega\end{pmatrix}\frac{\omega_p^2}{4\pi}\begin{pmatrix}\tilde{E}_x \\ \tilde{E}_y\end{pmatrix} + \alpha\begin{pmatrix}\cancel{\tilde{B}_y} \\ -\tilde{B}_x\end{pmatrix}$$

V_0

$$[\Omega^2 - (\omega - V_D k_z)^2]\tilde{J}_x =$$

$$\rightarrow \tilde{J}_x = \frac{-i(\omega - V_D k_z)}{\Omega^2 - (\omega - V_D k_z)^2}\frac{\omega_p^2 \tilde{E}_x}{4\pi} - \frac{\Omega \quad \tilde{E}_y}{\Omega^2 - (\omega - V_D k_z)^2}\frac{\omega_p^2}{4\pi}$$

$$\sigma_{xx} = -\frac{i\omega_p^2}{4\pi}\frac{\omega - V_D k_z}{\Omega^2 - (\omega - V_D k_z)^2}, \quad \sigma_{xy} = -\Omega\frac{\omega_p^2}{4\pi(\ )}$$

$$\sigma_{yy} = \sigma_{xx}, \quad \sigma_{yx} = -\sigma_{xy}$$

$$\chi = \frac{4\pi i}{\omega}\sigma$$

$$\epsilon_{xx} = 1 + \frac{\omega_p^2}{\omega}\frac{(\omega - V_D k_z)}{\Omega^2 - (\omega - V_D k_z)^2} + S_i = \epsilon_{yy}$$

$$\epsilon_{xy} = 1 - \frac{i\omega_p^2}{\omega}\frac{\Omega}{\Omega^2 - (\omega - V_D k_z)^2} +$$