OLD BINNEY CHV. 5

From 5.8 $\longrightarrow$ 5.12 b

$$\cancel{\frac{\partial \bar{v}_0}{\partial t}} + \boxed{\varepsilon \frac{\partial \bar{v}_1}{\partial t}} + \cancel{(\bar{v}_0 \bar{\nabla}) \bar{v}_0} + \boxed{\varepsilon (\bar{v}_1 \bar{\nabla}) \bar{v}_0} + \boxed{\varepsilon (\bar{v}_0 \bar{\nabla}) \bar{v}_1} + \varepsilon^2 \cancel{(\bar{v}_1 \bar{\nabla})} \bar{v}_1 =$$

$$= \underbrace{- \frac{\bar{\nabla} p_0}{\rho_0 + \varepsilon \rho_1}} \boxed{- \frac{\varepsilon \bar{\nabla} p_1}{\rho_0 + \varepsilon \rho_1}} - \cancel{\bar{\nabla} \phi_0} \boxed{- \varepsilon \bar{\nabla} \phi_1}$$

$$- \frac{\bar{\nabla} p_0}{(\rho_0^2 - \varepsilon^2 \cancel{\rho_1^2})} (\rho_0 - \varepsilon \rho_1) = \cancel{\frac{-\bar{\nabla} p_0}{\rho_0}} + \boxed{\frac{\varepsilon \rho_1 \bar{\nabla} p_0}{\rho_0^2}}$$

$$\boxed{} = - \frac{\varepsilon \bar{\nabla} p_1}{(\rho_0^2 - \varepsilon^2 \cancel{\rho_1^2})} (\rho_0 - \varepsilon \rho_1) = \boxed{\frac{-\varepsilon \bar{\nabla} p_1}{\rho_0}} + \cancel{\frac{\varepsilon^2 \rho_1 \bar{\nabla} p_1}{\rho_0^2 - \varepsilon^2 \rho_1^2}}$$

From eq. of the equilib.

II order

remnant parts $/\varepsilon$ $\Longrightarrow$ eq. 5-12b

$$= -\bar{\nabla} h_1 - \bar{\nabla} \phi_1$$

From definition of $h(\bar{x},t)$ 5-14

$$h(\bar{x},t) \equiv \int_0^{\rho(\bar{x},t)} \frac{dp(\rho')}{d\rho'}$$

$$h = h_0 + \varepsilon h_1$$

$$h_0 + \varepsilon h_1 = \int_0^{\rho_0} \frac{dp(\rho')}{\rho'} + \int_0^{\rho_0 + \varepsilon \rho_1} \frac{dp(\rho')}{\rho'}$$

$$\varepsilon h_1 = \left(\frac{dp}{d\rho}\right)_0 \frac{1}{\rho_0} \varepsilon \rho_1$$

$$h_1 = \left(\frac{dp}{d\rho}\right)_0 \frac{\rho_1}{\rho_0} = v_s^2 \frac{\rho_1}{\rho_0} = \frac{p_1}{\rho_0} \quad \text{5-12.d}$$

$$\bar{\nabla} h_1 = \bar{\nabla}\left(\frac{p_1}{\rho_0}\right) =$$

$$= \frac{\rho_0 \bar{\nabla} p_1 - p_1 \bar{\nabla} \rho_0}{\rho_0^2} =$$

$$= \frac{\bar{\nabla} p_1}{\rho_0} - \frac{\left(\frac{dp}{d\rho}\right)_0 \rho_1 \bar{\nabla} \rho_0}{\rho_0^2} =$$

$$= \frac{\bar{\nabla} p_1}{\rho_0} - \frac{\frac{\bar{\nabla} p_0}{\cancel{\bar{\nabla} \rho_0}} \rho_1 \cancel{\bar{\nabla} \rho_0}}{\rho_0^2}$$

$$\bar{\nabla} h_1 = -\frac{\rho_1}{\rho_0^2} \bar{\nabla} p_0 + \frac{1}{\rho_0} \bar{\nabla} p_1 \longrightarrow \text{5-12 b}$$

OLD BINNEY CHP. 5

From 5-19 $\longrightarrow$ 5-18 $\longrightarrow$ 5-20

$$\rho_1 = c\, e^{i(\bar{k}\bar{x} - \omega t)} \qquad i(\bar{k}\bar{x} - \omega t) = \text{☁}$$

$$\frac{\partial \rho_1}{\partial t} = c\, e^{\text{☁}}(-\omega i)$$

$$\frac{\partial^2 \rho_1}{\partial t^2} = c\, e^{\text{☁}}(-\omega^2)$$

$$\frac{\partial^2 \rho_1}{\partial x_1^2} = \frac{\partial}{\partial x 1}\left(c\, e^{\text{☁}}(i k_1)\right) = c\, e^{\text{☁}}(-1\, k_1^2)$$

5-18

$$\cancel{c}\, \cancel{e^{\text{☁}}}(-\omega^2) - v_s^2\, \cancel{c}\, \cancel{e^{\text{☁}}}\left[-1(k_1^2 + k_2^2 + k_3^2)\right] - 4\pi G \rho_0 \cancel{c}\, \cancel{e^{\text{☁}}} = 0$$

$$-\omega^2 + k^2 v_s^2 - 4\pi G \rho_0 = 0 \longrightarrow 5\text{-}20$$