



(a)

$$V_{\text{crit}} = \frac{\beta}{\left\{ k^2 + \ell^2 + \frac{f_0^2}{4N^2 \ell^2} \right\}}$$

$$k = 2\pi/\lambda$$

$$\lambda_1 = 2.83 \cdot 10^7 \text{ m} \quad k_1 = 2.22 \cdot 10^{-7} \frac{1}{\text{m}}$$

$$\lambda_3 = \left(\frac{2.83}{3} \right) \cdot 10^7 \text{ m} \quad k_3 = 3 k_1$$

$$(u_{crit})_1 = \frac{1.6 \cdot 10^{-11}}{(2.22 \cdot 10^{-11})^2 \cdot \frac{10^{-8}}{4(4 \cdot 10^{-4})}}$$

$$(u_{crit})_1 = 90,45 \text{ m/s}$$

$$(u_{crit})_3 = 28.01 \text{ m/s}$$

(b) if $u > u_{crit}$

$$\Rightarrow \{u \propto \exp\{\sqrt{r}\}\}$$

and not $\{u \propto \exp\{i/m\}\}$

$$m^2 = ?$$

$$u = u_{\text{crit}} + \Delta$$

$$= u_{\text{crit}} \left(1 + \frac{\Delta}{u_{\text{crit}}} \right)$$

assume $\Delta/u_{\text{crit}} \ll 1$

$$m^2 \approx \frac{-\Delta}{V_{\text{eff}}} \left\{ \frac{1}{4H^2} + \frac{V^2}{f^2(k^2 + R)} \right\}$$

Note: $m^2 < 0$

$$\underline{\Psi} = \underline{\Psi}_0 \exp\{im\tau\}$$

$$\psi \propto \exp \left\{ \pm i m |z| + \frac{z}{2H} \right\}$$

$$\textcircled{2} \frac{d}{dt} = \frac{\partial}{\partial t} + u \frac{\partial}{\partial x} + v \frac{\partial}{\partial y}$$

consider $e = \bar{e}$

$$u \frac{\partial}{\partial x} u = (\bar{u} + u') \frac{\partial}{\partial x} (\bar{u} + u') \\ = \bar{u}' \frac{\partial}{\partial x} u'$$

$$\frac{\partial u'}{\partial x} + f v' = -g \frac{\partial \eta'}{\partial x}$$

$$\frac{\partial v'}{\partial x} + f u' = -g \frac{\partial \eta'}{\partial y}$$

$$\frac{\partial \eta'}{\partial t} + H \left(\frac{\partial u'}{\partial x} + \frac{\partial v'}{\partial y} \right) = 0$$

$$\frac{\partial \eta'}{\partial x^2} + f \eta'$$

$$-gH \left(\frac{\partial^2 \eta'}{\partial x^2} + \frac{\partial^2 \eta'}{\partial y^2} \right) = 0$$

(c)

$$\eta' = \eta_0 \exp \{ i(k_x x + k_y y - \omega t) \}$$

$$\frac{\partial}{\partial t} \psi' = -i \hat{H} \psi'$$

$$\frac{\partial}{\partial x} \psi' = +ik \psi'$$

$$\frac{\partial}{\partial y} \psi' = +il \psi'$$

$$[(i\nu)^2 + f^2 - gH] \{ (ik)^2 + (il)^2 \} \neq 0$$

$$\nu^2 = f^2 + gH(k^2 + l^2)$$

$$\nu = \pm \sqrt{f^2 + gH(k^2 + l^2)}$$

(d) $K, \ell \rightarrow \text{Small}$

$$v^2 \approx f^2$$

$$v \approx \pm f$$

(a) $\frac{w u}{L} + \frac{u w}{L} + \frac{u w}{L} + \frac{w^2}{H}$

$-10^{-4} u + 10 \sim 10$

$w \left[10^{-5} + 10^{-5} + 10^{-5} + \frac{w}{H} \right]$

$10^{-3} + 10 \sim 10$

b) $\frac{\omega^2}{H} \sim g$

$$\omega^2 \sim 10, 10$$

$$\omega \sim 10 \text{ m/s}$$