3.82 $\frac{d}{\partial z} U_{EM} + \frac{d}{\partial z} U_{EK} = 0 \qquad A_{tr} = \frac{\lambda_1 \lambda_u N_u}{2}$ (3.50)

$$U_{EM} = \frac{A_{tr}\lambda_1}{2\pi}\int \partial\theta \, u_{EM} = \frac{A_{tr}\lambda_1}{2\pi}\int \partial\theta \frac{\epsilon_0}{2}\left(E^2 + c^2 B^2\right)$$

$$= \frac{A_{tr}\lambda_1}{2\pi}\int \partial\theta \, 2\epsilon_0 |E|^2$$

$$\frac{d}{\partial z} U_{EM} = \frac{-eK[JJ]}{2\gamma_r}\frac{N_{\cancel{\lambda}}}{2\pi N_\Delta}\int \partial\theta \sum_{j\in\Delta} E^* e^{-i\theta_j} + c.c.$$

$$= \frac{-eK[JJ]}{2\gamma_r}\sum_j \frac{e^{-i\theta_j}}{\Delta\theta}\int_{\theta_j - \Delta\theta/2}^{\theta_j + \Delta\theta/2} \partial\theta \, E^* \theta + c.c.$$

$$\frac{d}{\partial z} U_{EM} = \frac{-eK[JJ]}{2\gamma_r}\sum_j \left[E^*(\theta_j)e^{-i\theta_j} + E(\theta_j)e^{i\theta_j}\right]$$

$$[\gamma_r mc^2]\ \frac{d\eta_j}{\partial z} = \frac{eK[JJ]}{2\gamma_r^2 mc^2}\left[E e^{i\theta_j} + E^* e^{-i\theta_j}\right] \gamma_r mc^2$$

$$\frac{dU_{KE}}{\partial z} = \frac{eK[JJ]}{2\gamma_r}\left[E e^{i\theta_j} + E^* e^{-i\theta_j}\right]$$

(sum over all e^-)

$\Downarrow$

$$\frac{dU_{KE}}{\partial z} = \frac{eK[JJ]}{2\gamma_r}\sum_j\left[E e^{i\theta_j} + E^* e^{-i\theta_j}\right]$$

$$\frac{dU_{EM}}{\partial z} = -\frac{\partial U_{KE}}{\partial z} \Rightarrow \frac{\partial U_{EM}}{\partial z} + \frac{dU_{KE}}{\partial z} = \varnothing$$