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$$\boxed{\frac{d^2T^*}{d\eta^2} + \frac{Pr}{2}\cdot f(\eta)\cdot \frac{dT^*}{d\eta} = 0}$$

· Basic assumptions : $\delta/\delta_T \approx Pr^{1/3}$, $\eta = y\sqrt{U_\infty/2\nu x}$, $\eta_T = y/\delta$

$\eta = y/\delta$

$$\frac{\delta}{\delta_T} = \frac{y/\eta}{y/\eta_T} = \eta_T/\eta = Pr^{1/3}$$

$\therefore \eta_T = \eta \cdot Pr^{1/3}$ ← $\times Pr^{2/3}$

$\eta_T \cdot Pr^{2/3} = \eta \cdot Pr$ ← $Pr = 1,\ \delta_T \approx \delta$

$= \eta \cdot (1)$

$1/\eta \cdot Pr^{2/3} = 1/\eta_T$

· $f(\eta) \equiv \dfrac{\psi}{U_\infty \cdot \sqrt{2\nu x/U_\infty}}$, $\eta \equiv y \cdot \sqrt{U_\infty/2\nu x}$

$= \cdot 1/\eta$

$f(\eta)\cdot Pr^{2/3} = f(\eta_T) = f(\eta \cdot Pr^{1/3})$

$f(\eta) = C \cdot \frac{1}{\eta}$ 이면

$$f(\eta)\cdot Pr^{2/3} = C\cdot\frac{Pr^{2/3}}{\eta} = C\cdot\frac{\cancel{Pr^{2/3}}}{\cancel{Pr^{2/3}}\,\eta_T} = C\cdot\frac{1}{\eta_T} = f(\eta_T)$$

이겠으나,

$f(\eta) = g(\eta)\cdot\frac{1}{\eta}$ 이면 $f(\eta)\cdot Pr^{2/3} \neq f(\eta_T)$

가령 $g(\eta) = \eta^2$ 이면,

$f(\eta) = \eta$ 인데, $f(\eta)\cdot Pr^{2/3} = \eta\cdot Pr^{2/3} = \eta_T\cdot Pr^{4/3} = Pr^{4/3} f(\eta_T) \neq f(\eta_T)$

그런데 $f(\eta)$은 실제로는 $\dfrac{\psi}{U_\infty\sqrt{2\nu x/U_\infty}}$ 이므로,
$$f(\eta) = \frac{\psi}{U_\infty}\cdot\frac{1}{y}\cdot y\sqrt{\frac{U_\infty}{2\nu x}} = \frac{\psi}{U_\infty y}\cdot\eta$$
$$= \frac{\psi}{U_\infty y}\eta^2\cdot\frac{1}{\eta}$$

$\therefore$ $f(\eta)\cdot Pr^{2/3} = f(\eta_T) = f(\eta \cdot Pr^{1/3})$ 라고 할수 없음

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$U_\infty \cdot df(\eta)/ \ldots \left\{ -\frac{\ldots}{2x}\eta \cdot d^2f(\eta)/d\eta^2 \right\} + \frac{1}{2}\cdot\sqrt{\frac{2\nu U_\infty}{x}}\cdot\left(\eta\cdot df/d\eta - f\right) U_\infty \cdot \sqrt{U_\infty/2\nu x} \ldots d^2f(\eta)/ \ldots = \nu \cdot \frac{U_\infty^2}{2\nu x}\cdot d^3f(\eta)/d\eta^3$

$$-\frac{U_\infty^2}{2x}\cdot\eta\cdot\cancel{d^3f(\eta)/d\eta^3} + \frac{U_\infty^2}{2x}\left(\eta\cdot\cancel{d^3f(\eta)/d\eta^3} - f(\eta)\cdot d^2f(\eta)/d\eta^2\right) = \frac{U_\infty^2}{x}\cdot d^3f(\eta)/d\eta^3$$

$\cancel{U_\infty^2/x}\cdot d^3f(\eta)/d\eta^3 + \cancel{U_\infty^2/2x}\cdot f\cdot d^2f(\eta)/d\eta^2 = 0$

$\hookrightarrow$ $\boxed{\frac{df}{d\eta}\cdot\frac{d^2f}{d\eta^2} \neq \frac{d^3f}{d\eta^3} = \frac{d}{d\eta}\left(\frac{d^2f}{d\eta^2}\right)}$

$2\cdot d^3f(\eta)/d\eta^3 + f\cdot d^2f(\eta)/d\eta^2 = 0$ Ans.

nonlinear third-order ODE !

$y\uparrow$