Law of the wall

w

y

$\bar{u}$

(A) (B) (C)

$\bar{u} = \bar{u}(y, \nu, w, u_\star)$
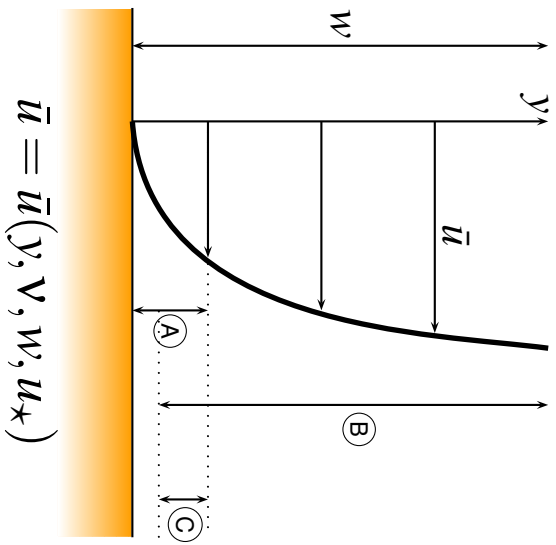
$\eta = y/w, \quad y^+ = u_\star y/\nu$

A. $\dfrac{\bar{u}}{u_\star} = f(y^+), \qquad \eta \ll 1$

B. $\dfrac{\bar{u}_0 - \bar{u}}{u_\star} = g(\eta), \qquad y^+ \gg 1$

C. $\eta \ll 1$ AND $y^+ \gg 1$ if $Re = u_\star w/\nu \gg 1$

$\dfrac{y}{u_\star} \dfrac{\partial \bar{u}}{\partial y} = u_\star y^+ f'(y^+) = -u_\star \eta\, g'(\eta) = \dfrac{u_\star}{\kappa}$

$$\begin{cases} \dfrac{\bar{u}}{u_\star} = \dfrac{1}{\kappa}\ln y^+ + A & \eta \ll 1 \\[2mm] \dfrac{\bar{u}_0 - \bar{u}}{u_\star} = -\dfrac{1}{\kappa}\ln \eta + B & y^+ \gg 1 \end{cases}$$