Given that $\int_0^1 (f-f^2)d\eta$ is some constant, α

We restate the integral b.l. eqn as

$$\rho U^2 \alpha \frac{d\delta}{dx} = \tau_0$$

We may rewrite

$$\tau_0 = \mu\left[\frac{\partial v_x}{\partial y}\right]_{y=0} = \frac{\mu U}{\delta}\left(\frac{df}{d\eta}\right)_{\eta=0} = \frac{\mu U}{\delta(x)}\beta$$

where $\beta \equiv \left(\frac{\partial f}{\partial \eta}\right)_{\eta=0}$ is some constant also.

Thus, we now have a governing eqn. for $\delta(x)$.

$$\rho U^2 \alpha \frac{d\delta}{dx} = \frac{\mu U}{\delta}\beta$$

$$\delta \frac{d\delta}{dx} = \frac{\mu\beta}{\rho U \alpha} \qquad x = 0\ ,\ \delta = 0.$$

soln is $\boxed{\delta = \left(\frac{2\mu\beta}{\rho U \alpha}x\right)^{1/2}}$ thus δ varies as $\sqrt{x}$!

An approximation to $v_x\left(\frac{y}{\delta(x)}\right)$ is.

$$\frac{v_x}{U} = \frac{3}{2}\frac{y}{\delta(x)} - \frac{1}{2}\left(\frac{y}{\delta(x)}\right)^3 \longrightarrow f = \frac{3}{2}\eta - \frac{1}{2}\eta^3$$

this solution agrees with the boundary condition.

BC1 $y = 0$, $v_x = 0$

BC2 $y = \delta(x)$, $\frac{\partial v_x}{\partial y} = 0$ "smoothness" condition

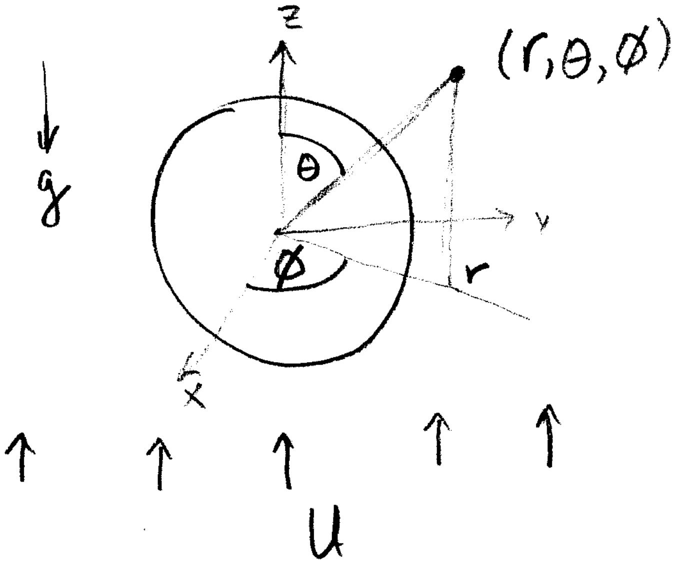
BC3 $y = \delta(x)$, $v_x = U$

Calc. α and β and then solve for $\delta(x)$.

Then Calc. F_x, the Force on the Plate!

Slow Flow Around a Solid Sphere: 2-dimensional Flow:

Stoke's Law Derivation (Middleman, 168-172)



We "fix" the r, θ, ϕ coordinate system to the falling sphere. U appears to the sphere as a uniform constant velocity field at steady state (when drag force = gravity force).

Symmetry dictates that $v_\phi = 0$ Mon 2/6/06

But we expect $v_\theta = v_\theta(r, \theta)$, $v_r = v_r(r, \theta)$

For a Newtonian fluid of constant ρ we may write

Continuity Eqn: Table B.4.

$$\cancelto{0}{\frac{\partial \rho}{\partial t}} + \frac{1}{r^2}\frac{\partial}{\partial r}(\rho r^2 v_r) + \frac{1}{r \sin\theta}\frac{\partial}{\partial \theta}(\rho v_\theta \sin\theta) + \cancelto{0}{\frac{1}{r \sin\theta}\frac{\partial}{\partial \phi}(\rho v_\phi)} = 0$$

ρ Const.

$$\boxed{\frac{1}{r^2}\frac{\partial}{\partial r}(r^2 v_r) + \frac{1}{r \sin\theta}\frac{\partial}{\partial \theta}(v_\theta \sin\theta) = 0}$$