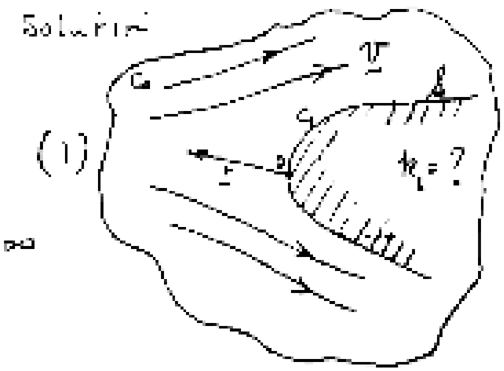
Lecture 10

"L^3" Asymptotic Theory of Laminar Forced-Convection for Pe>>1

*Laminar Forced-Convection Mass or Heat Transfer**

Asymptotic large-Pe Solution to



$$\underline{v}\cdot\nabla C = \frac{1}{Pe}\nabla^2 C$$

$C = C_1$ on S

$C = C_\infty$ for $|\underline{x}| \to \infty$

Geometry of S

Planar

$$ds^2 = dy^2 + a^2 dx^2 + dz^2$$

$r \equiv r_0 \equiv 1$

$a = 1 + a_1(x)\, y + \dots$

Axisymmetric

$$ds^2 = dy^2 + a^2 dx^2 + r^2 d\theta^2$$

$r(x,y) = r_0(x) + r_1(x)\, y + \dots$

$a = 1 + a_1(x)\, y + \dots$

Fluid velocity $\underline{v}$

$v_x = u(x,y)$, $v_y = v(x,y)$

$v_z = \text{const}$ (planar) or v_θ independent of θ (axisym.)

$= 0$, say

*See Handout MT15.pdf

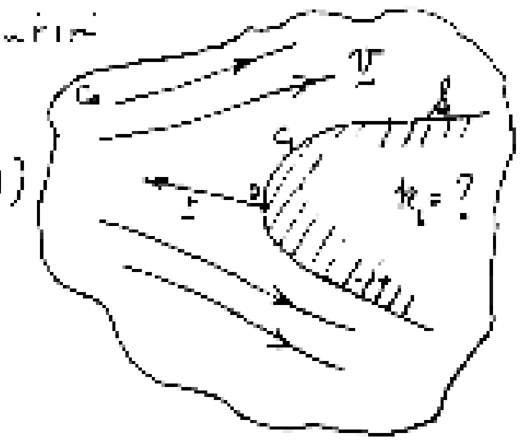
*Laminar Forced Convection Mass or Heat Transfer**

Asymptotic large-Pe Solution to

$$\mathbf{v}\cdot\nabla c = \frac{1}{Pe}\nabla^2 c \qquad (1)$$

$c = c_1$, on $\mathcal{S}$

$c = c_\infty$ for $|\mathbf{r}| \to \infty$

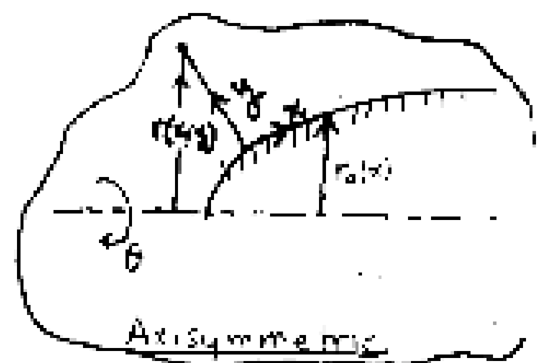


Geometry of $\mathcal{S}$

$$ds^2 = dy^2 + \alpha^2 dx^2 + dz^2$$

$r \equiv r_0 \equiv 1$

$\alpha = 1 + \alpha_1(x)\, y + \cdots$



$$ds^2 = dy^2 + \alpha^2 dx^2 + r^2 d\theta^2$$

$r(x,y) = r_0(x) + r_1(x)\, y + \cdots$

$\alpha = 1 + \alpha_1(x)\, y + \cdots$

Fluid velocity $\mathbf{v}$

$v_x = u(x,y)$, $v_y = v(x,y)$

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