Biological Hydrodynamics

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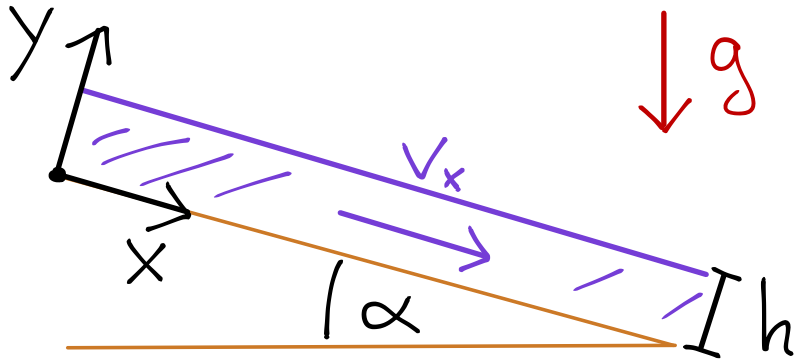
Next Tutorial: Thursday **14th November**, 14:50 - 16:20, MPI PKS Seminar Room 3

Tutorial 3: Flow down an incline



Consider a layer of height h of an incompressible Newtonian fluid of density ρ and viscosity η that is placed on an inclined surface as depicted, with α the angle of inclination to the horizontal. Even though there is a no-slip boundary condition at the interface between the fluid and the surface ($v_x = v_y = 0$ at $y = 0$), the gravity field $\underline{g}$ will drive the fluid down the inclination.

1. Write down the expression for force balance in x and y direction considering the gravity field and neglecting inertial terms. Note that pressure and velocity do not change in the x direction.

2. The pressure above the fluid layer is P_0. Calculate the pressure profile $P(y)$.

3. Calculate the velocity profile $v_x(y)$, given that the normal stress at the free surface at $y = h$ must match the pressure above the layer (in other words, $\sigma^{\mathrm{d}}_{\mathrm{xy}} = 0$ at $y = h$).

4. Calculate the volumetric flow rate Q (the total volume of fluid per unit time that passes through a crossection of width Z). If you double the height of the layer, by what factor do you increase Q?