

Supplementary Material

$$\begin{aligned}
 \rho \left(\frac{D\vec{v}}{Dt} \right) &= \rho \vec{f} - \nabla \bar{p} + \mu \nabla^2 \vec{v} \\
 \rho \left(\frac{\partial \vec{v}}{\partial t} + u \frac{\partial \vec{v}}{\partial x} + v \frac{\partial \vec{v}}{\partial y} \right) &= \rho \vec{f} - \nabla \bar{p} + \mu \nabla^2 \vec{v} \\
 \rho \left(\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} \right) &= 0 - \left(\frac{\partial p_x}{\partial x} + \frac{\partial p_y}{\partial y} \right) + \mu \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} \right) \\
 \rho \left(\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} \right) &= 0 - \left(\frac{\partial p_x}{\partial x} + \frac{\partial p_y}{\partial y} \right) + \mu \left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} \right) \\
 \frac{\partial u}{\partial t} &= \omega U e^{-y \sqrt{\frac{\rho}{2\mu}}} \sin(\omega t - y \sqrt{\frac{\rho}{2\mu}}) \\
 \frac{\partial v}{\partial t} &= 0 \\
 \frac{\partial u}{\partial x} &= 0 \\
 \frac{\partial u}{\partial y} &= -\frac{\omega U}{\sqrt{2\mu}} e^{-y \sqrt{\frac{\rho}{2\mu}}} \cos(\omega t - y \sqrt{\frac{\rho}{2\mu}}) + \frac{\omega U}{\sqrt{2\mu}} e^{-y \sqrt{\frac{\rho}{2\mu}}} \sin(\omega t - y \sqrt{\frac{\rho}{2\mu}}) \\
 \frac{\partial v}{\partial x} &= \frac{\partial v}{\partial y} = 0 \\
 \frac{\partial^2 u}{\partial x^2} &= 0 \\
 \frac{\partial^2 u}{\partial y^2} &= 0 \\
 \frac{\partial^2 v}{\partial x^2} &= 0 \\
 \frac{\partial^2 v}{\partial y^2} &= 0 \\
 \Rightarrow \nabla^2 \bar{p} &= 0
 \end{aligned}$$

Figure S1 (a). The first photo of the solution of a student on the exercise, where the error is regarded as an error of the NS equation

则有:

$$\begin{aligned}
 \rho \left[-\omega U e^{-y \sqrt{\frac{\rho}{2\mu}}} \sin(\omega t - y \sqrt{\frac{\rho}{2\mu}}) \right. \\
 \left. - \frac{\omega U}{\sqrt{2\mu}} e^{-y \sqrt{\frac{\rho}{2\mu}}} \cos(\omega t - y \sqrt{\frac{\rho}{2\mu}}) \right. \\
 \left. + \frac{\omega U}{\sqrt{2\mu}} e^{-y \sqrt{\frac{\rho}{2\mu}}} \sin(\omega t - y \sqrt{\frac{\rho}{2\mu}}) \right] \\
 \text{则有 } \cos(\omega t - y \sqrt{\frac{\rho}{2\mu}}) = \sin(\omega t - y \sqrt{\frac{\rho}{2\mu}})
 \end{aligned}$$

不满足 NS 方程

Figure S1 (b). The second photo of the solution of a student on the exercise, where the error is regarded as an error of the NS equation