COMPUTATION OF THE ADDED MASS

$$f = -\ddot{q}\left[M \int_{Interface} \varphi_p \, \underline{n} . \underline{\varphi} \, dS \right]$$

Added mass $m_A = M \int_{Interface} \varphi_p \, \underline{n} . \underline{\varphi} \, dS$

$$\mathrm{div}\, \underline{\varphi}_u = 0$$

$$\underline{\varphi}_u = -\underline{\nabla} \varphi_p$$

interface

$$\underline{\varphi}_u . \underline{n} = \underline{\varphi} . \underline{n}$$

$$\Delta \varphi_p = 0$$

interface

$$-\underline{\nabla} \varphi_p . \underline{n} = \underline{\varphi} . \underline{n}$$

COMPUTATION OF THE ADDED MASS

$$\Delta \varphi_p = 0$$

interface

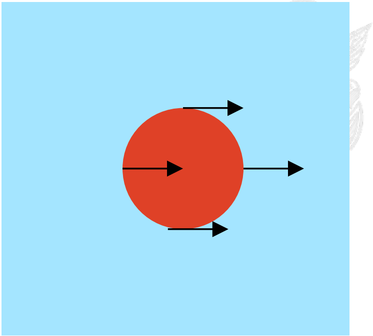
$$-\underline{\nabla}\varphi_p . \underline{n} = \underline{\varphi} . \underline{n}$$

A CYLINDER IMMERSED IN AN INFINITE FLUID DOMAIN

$$\Delta \varphi_p = 0$$

interface

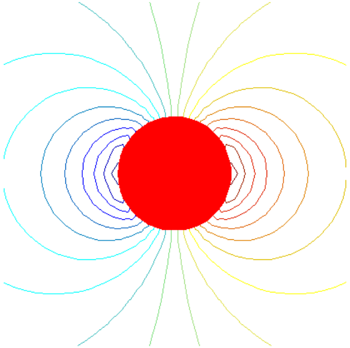
$$-\underline{\nabla}\varphi_p.\underline{n} = \underline{\varphi}.\underline{n}$$



$$\underline{\varphi}.\underline{n} = \cos\theta$$

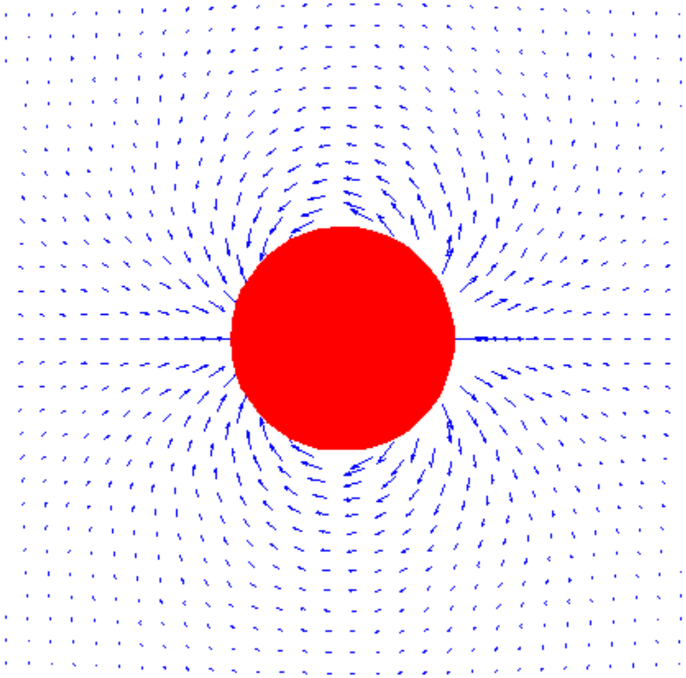
$$\Downarrow$$

$$\varphi_p(r,\theta) = \frac{\cos\theta}{r}$$

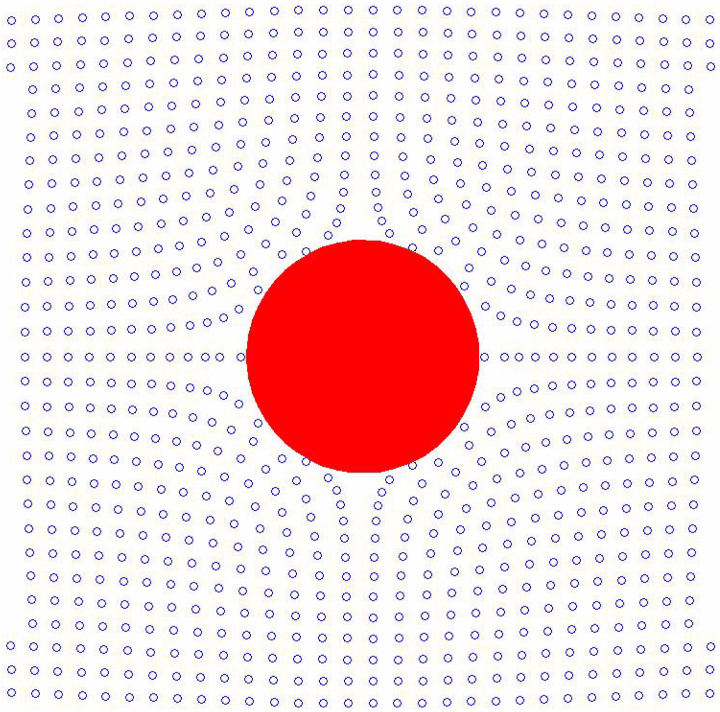


A CYLINDER IMMERSED IN AN INFINITE FLUID DOMAIN

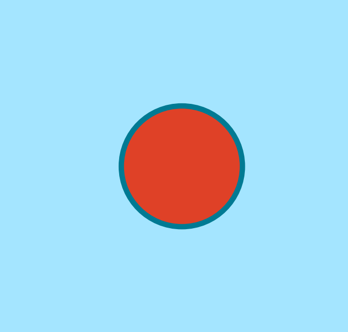
$$\underline{\varphi}_u = -\underline{\nabla}\varphi_p = \frac{1}{r^2}\left[(\cos\theta)\underline{e}_R + (\sin\theta)\underline{e}_\theta\right]$$



A CYLINDER IMMERSED IN AN INFINITE FLUID DOMAIN



A CYLINDER IMMERSED IN AN INFINITE FLUID DOMAIN



$$m_A = M \int_{Interface} \varphi_p \underline{n}.\underline{\varphi}\, dS$$

$$\varphi_p(r,\theta) = \frac{\cos\theta}{r}$$

$$m_A = M\pi$$ Dimensionless

$$m_A = \frac{M_A}{M_{Solid}} \qquad M = \frac{\rho R^2}{M_{Solid}}$$

$$M_A = \rho\pi R^2$$ Dimensional

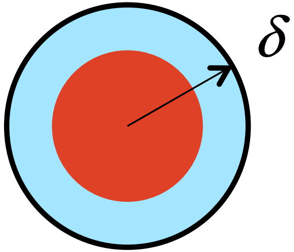
A CYLINDER IMMERSED IN AN INFINITE FLUID DOMAIN

$$M_{Solid} + M_A$$

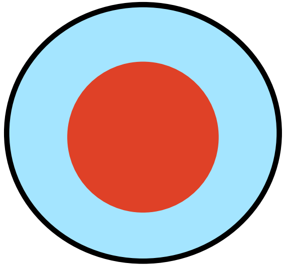
Apparent mass≈ double mas

(in that case !)

A CYLINDER IMMERSED IN A CONFINED FLUID DOMAIN

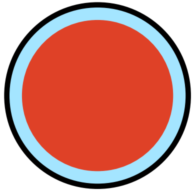


$$m_A = M\pi\left[\frac{\delta^2+1}{\delta^2-1}\right]$$



$\delta = 2$

$m_A \approx 1.7M\pi$



$\delta = 1.1$

$m_A \approx 10.5M\pi$

KINETIC ENERGY OF THE FLUID

$$K_C = \int_{\text{fluid domain}} \frac{1}{2} M u^2 dV$$

$$\underline{u}(\underline{x},t) = \dot{q}(t)\underline{\varphi}_u(\underline{x})$$

$$K_C = \frac{1}{2}\left[M \int_{\text{fluid domain}} \underline{\varphi}_u{}^2 dV \right] \dot{q}^2$$

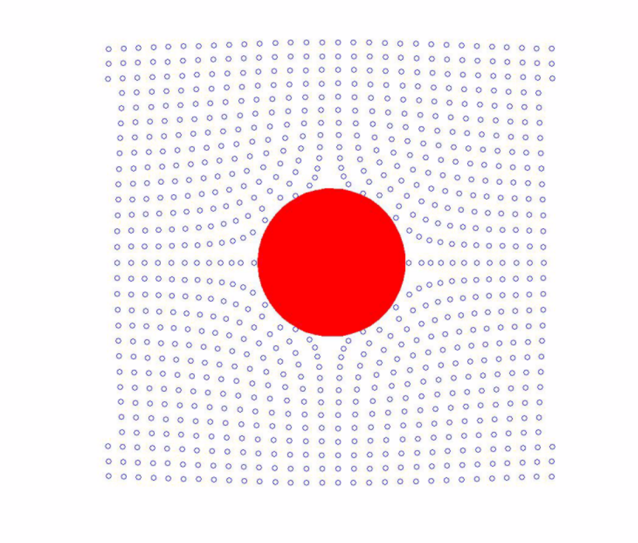
$$\underline{\varphi}_u = -\underline{\nabla}\varphi_p$$

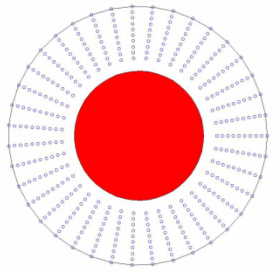
$$-\underline{\nabla}\varphi_p.\underline{n} = \underline{\varphi}.\underline{n}$$

$$K_C = \frac{1}{2}\left[M \int_{\text{interface}} \varphi_p \underline{n}.\underline{\varphi}\, dS \right] \dot{q}^2$$

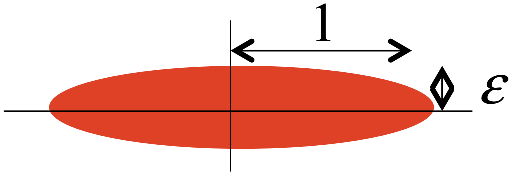
$$\boxed{K_C = \frac{1}{2} m_A \dot{q}^2}$$

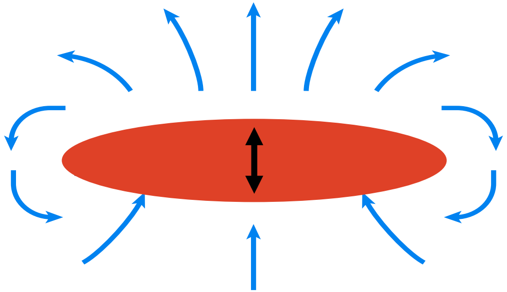
CONFINEMENT EFFECT

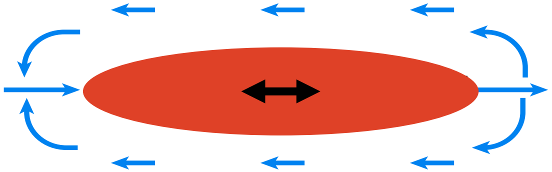




DIRECTIONAL ADDED MASS







$$m_A^Y = M\pi \qquad\qquad m_A^X = M\pi\varepsilon^2$$

$$m_A^Y >> m_A^X$$

ADDED MASS