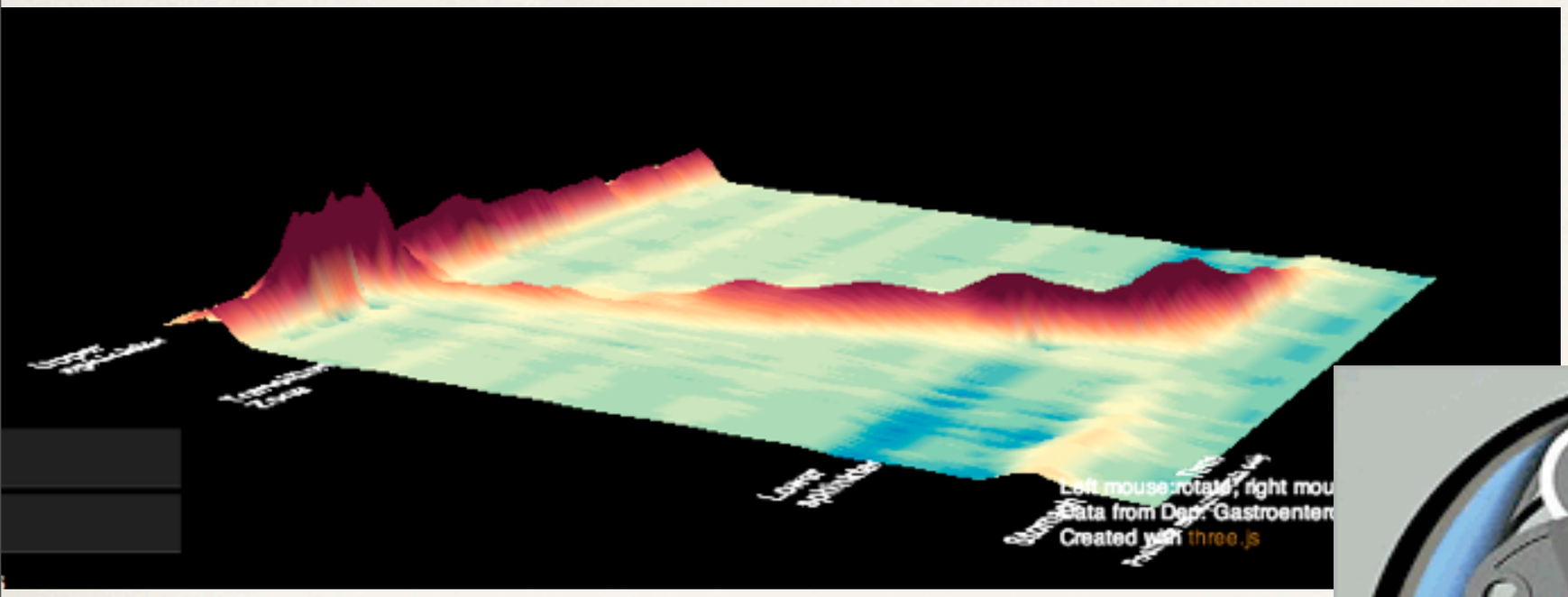

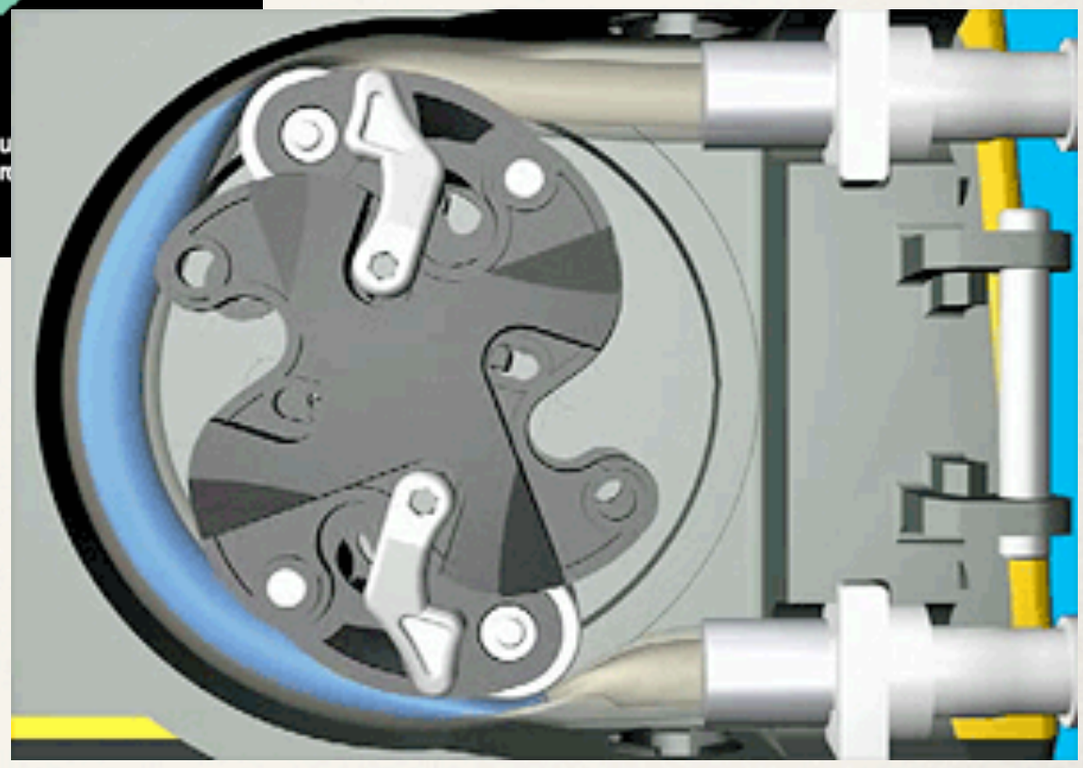

A Capsule in Peristaltic Flows

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PERISTALTIC PUMPING

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1. Introduction

Peristaltic pumping is a form of fluid transport that occurs when a progressive wave of area contraction or expansion propagates along the length of a distensible tube containing a liquid. Physiologically, peristaltic action is

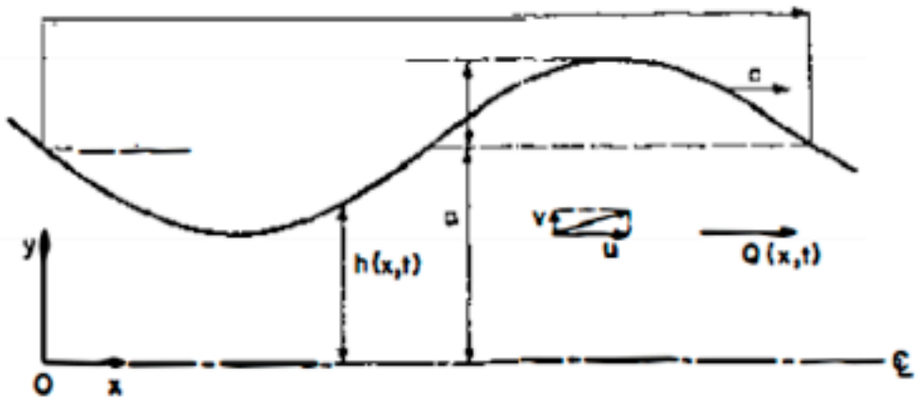


FIGURE 2. Nomenclature for periodic sine wave.

$$\nabla^2\psi_t + \psi_y\nabla^2\psi_x - \psi_x\nabla^2\psi_y = \nu\nabla^2\nabla^2\psi$$

streamfunction

wave speed

After introduction of the dimensionless variables

$$\xi \equiv 2\pi\frac{x}{\lambda}; \qquad \eta \equiv \frac{y}{a}; \qquad \tau \equiv 2\pi\frac{ct}{\lambda}; \qquad \chi \equiv \frac{\psi}{ac}; \qquad H \equiv \frac{h(x,t)}{a}$$

wavelength

Reynolds No.

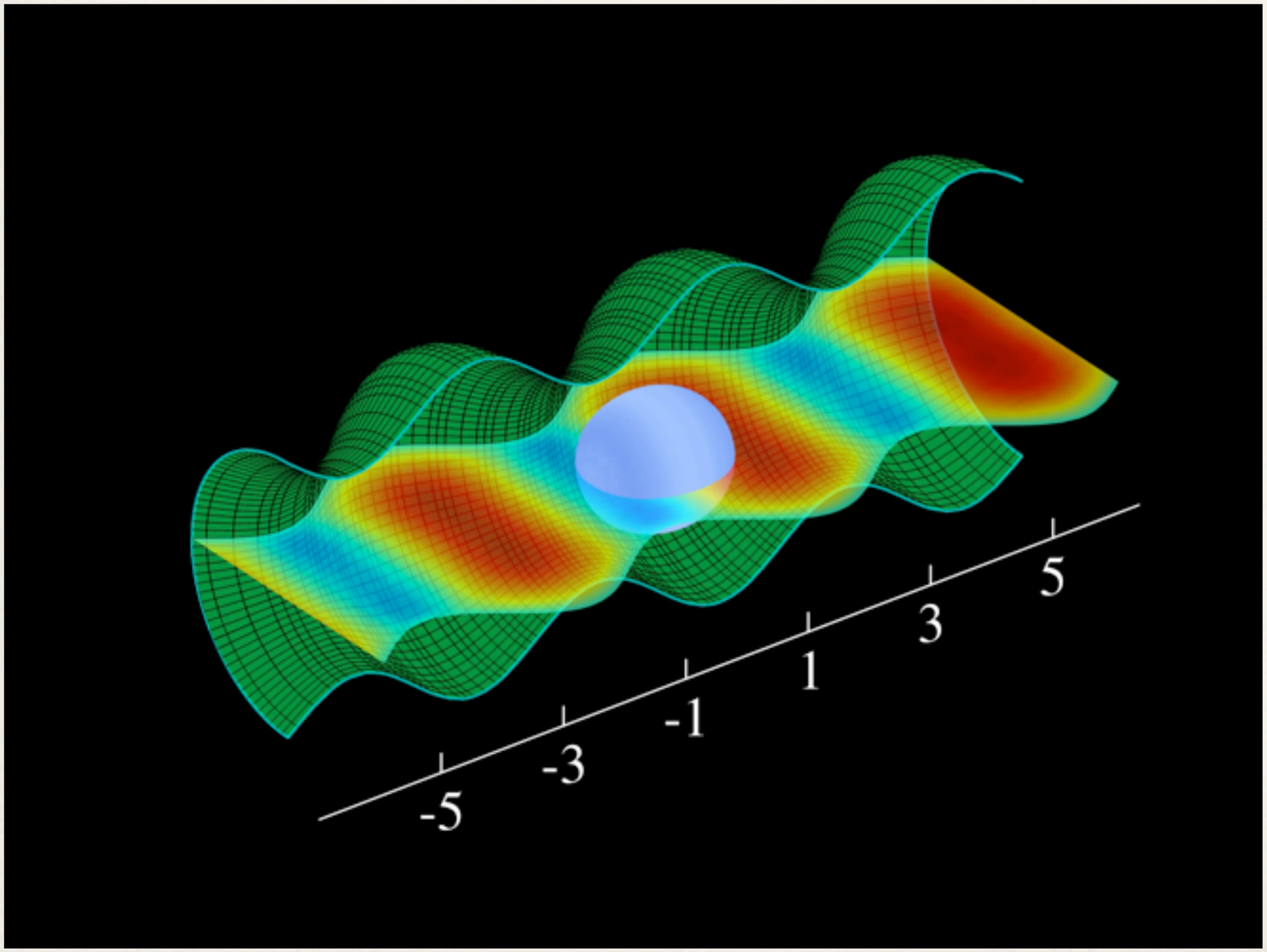
and the two important dimensionless parameters

$$\alpha \equiv 2\pi a/\lambda; \qquad \mathrm{R} \equiv (ac/\nu)\cdot\alpha$$

the vorticity equation becomes

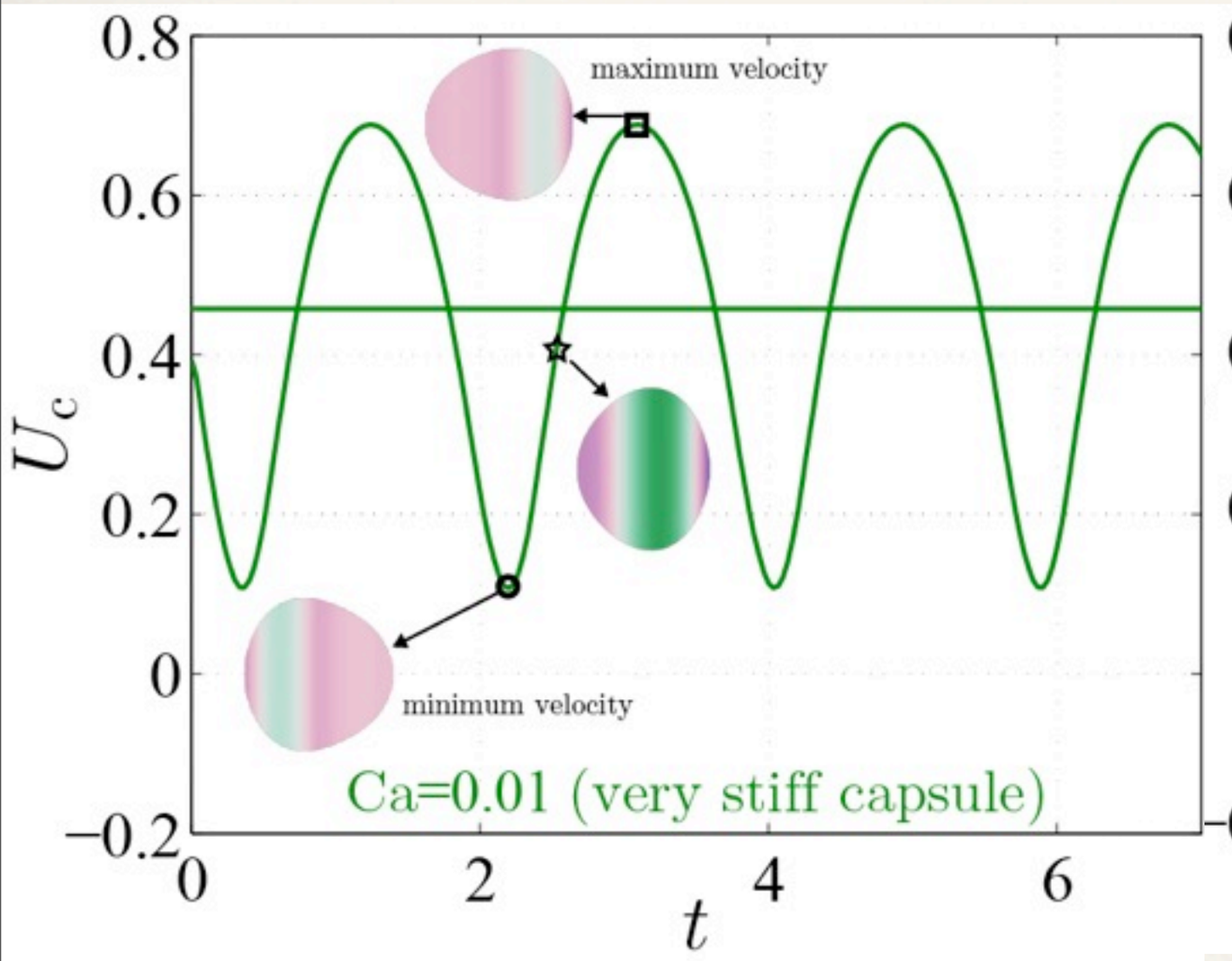
$$\mathrm{R}(\tilde{\nabla}^2\chi_\tau + \chi_\eta\tilde{\nabla}^2\chi_\xi - \chi_\xi\tilde{\nabla}^2\chi_\eta) = \tilde{\nabla}^2\tilde{\nabla}^2\chi \qquad 2.1$$

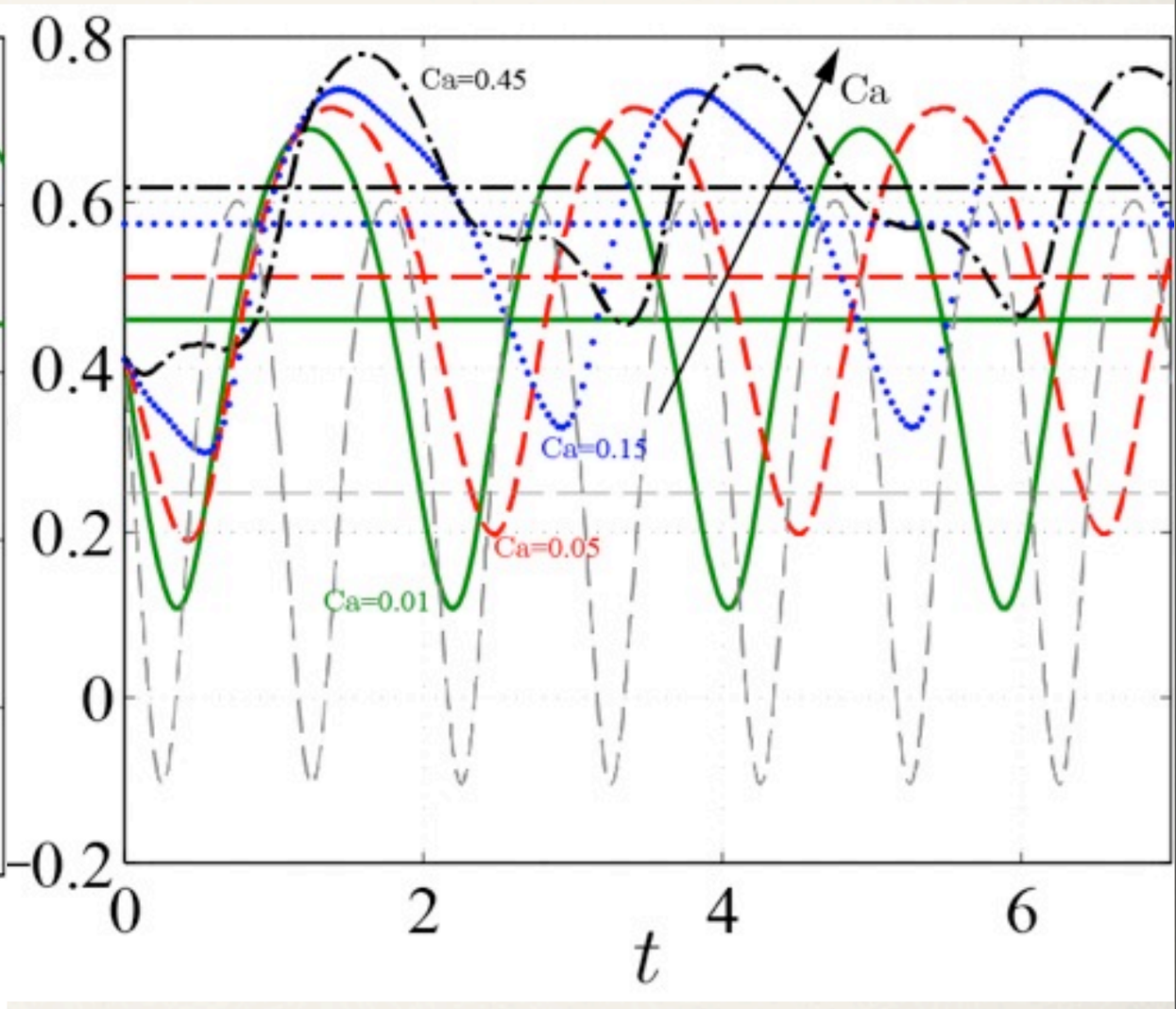
Stokesian peristalsis with capsule



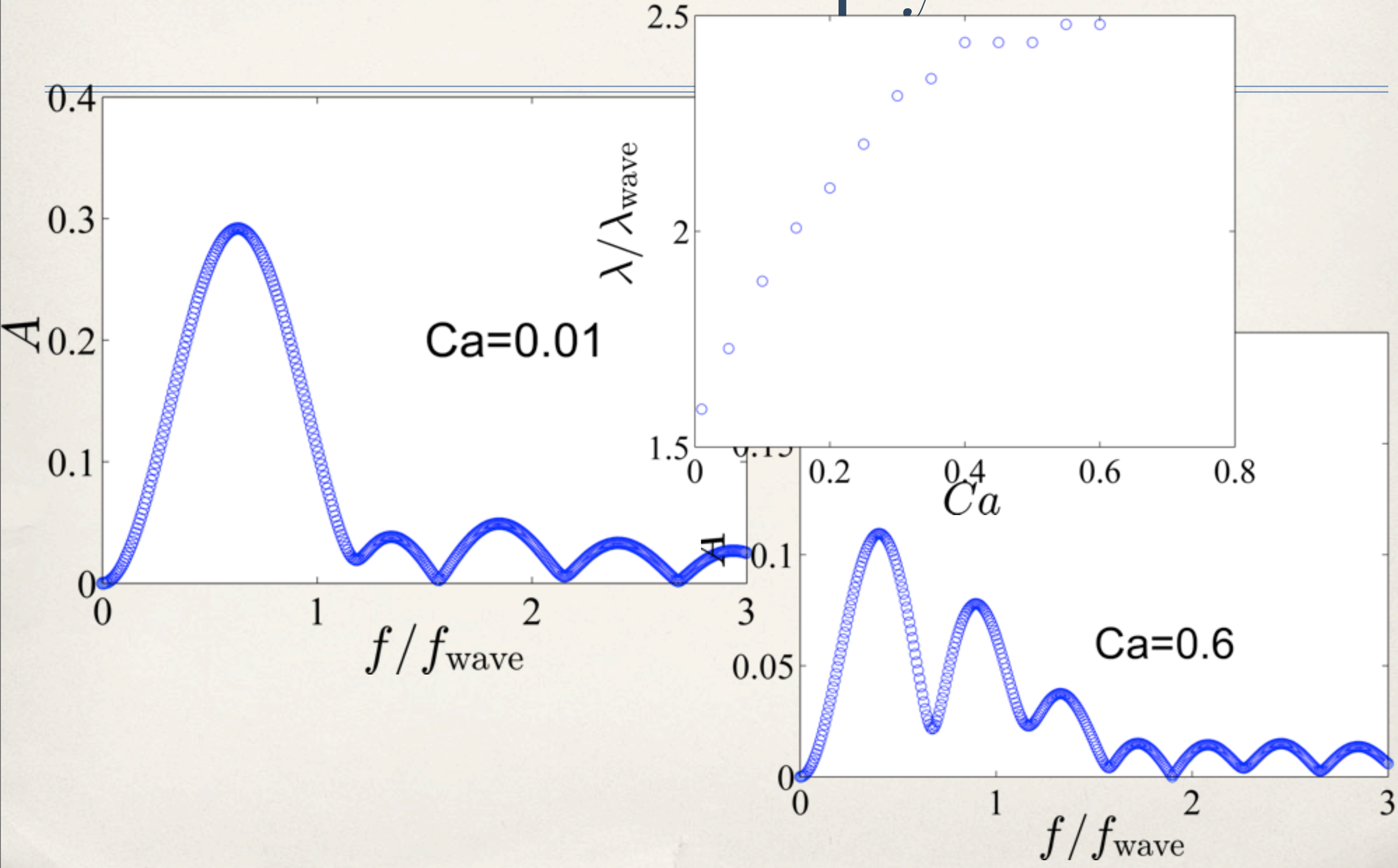
- Solve Stokes equation with moving boundaries.
- Calculate elastic forces on the membrane of the capsule
- Move the capsule by the velocity of the fluid interpolated to boundary points.

Deformability sets speed !





Periodic but not simply harmonic



Conclusion

- Maximum velocity saturates as a function of capillary number.
- Can be used to design a deformability based cell-sorting device.
- Membrane nonlinearity and flow-structure interaction can give rise to a new kind of mixing and maybe even chaotic time-dependent Stokes flows.