Vortex stretching in vibration induced streaming at high forcing

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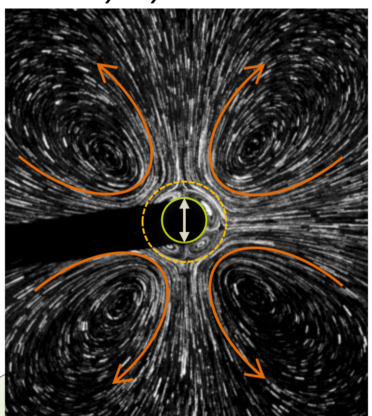
Streaming flow

Rayleigh-Schlichting streaming

viscous dissipation confined in the boundary layer around the vibrating beam.

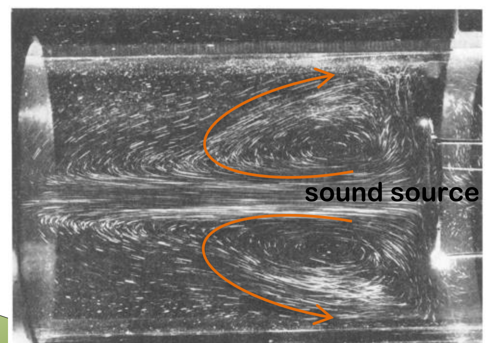


S. A. Bahrani, *Phys. Rev. Fluids* (under consid.)

$\sim Hz$

Eckart streaming

viscous dissipation in the bulk

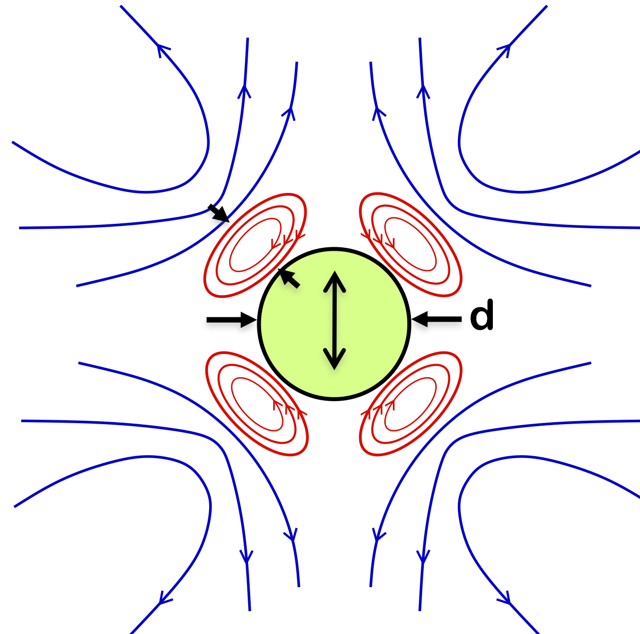


L. N. Liebermann, *Phys. Rev.* (1949)

$\sim MHz$

Viscous dissipation is responsible for the fluid motion

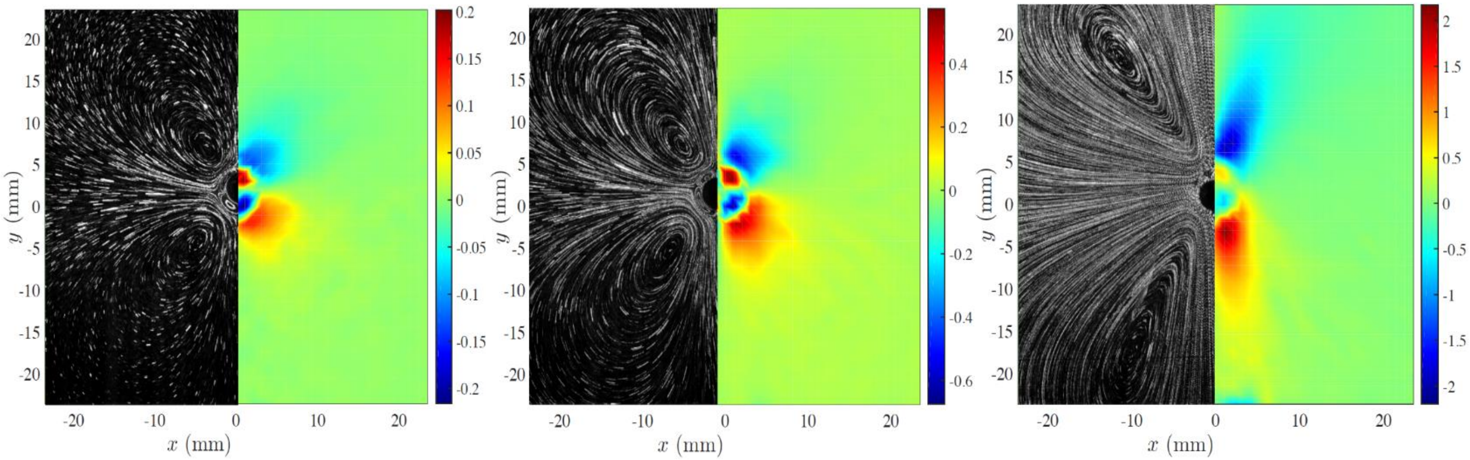
Theoretical grounds



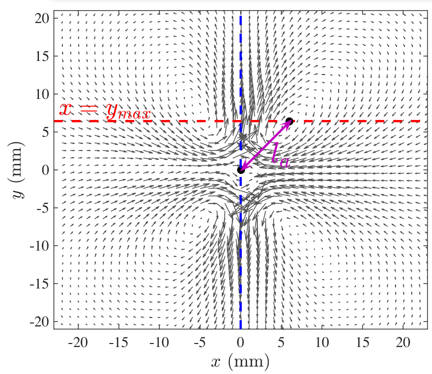
$$\rho\left(\frac{\partial \boldsymbol{v}}{\partial t} + (\boldsymbol{v}\cdot\nabla)\boldsymbol{v}\right) = -\nabla P + \mu\nabla^2\boldsymbol{v}$$

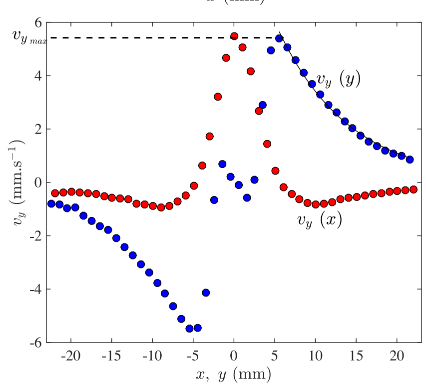
$$\mathcal{R} = \frac{\text{Convective}}{\text{Diffusive}}$$

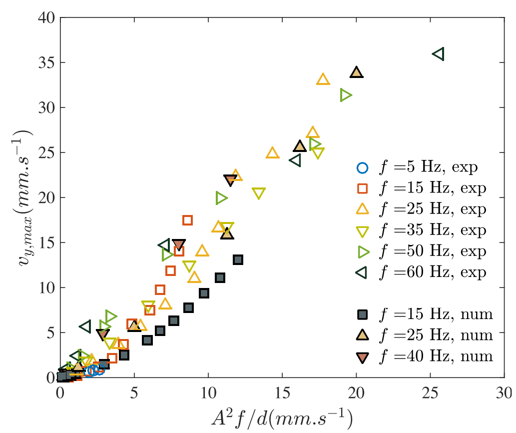
Results et discussion

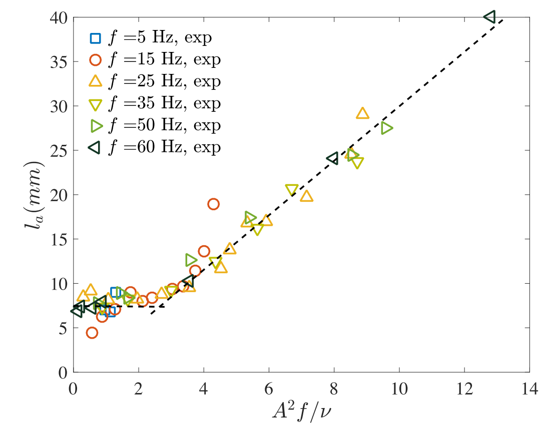


f = 25 Hz & A = 0.5 mm **f = 25 Hz & A = 1.0 mm** **f = 25 Hz & A = 1.8 mm**









- **Growth and stretching of vortices along the direction of the vibration with the increase of amplitude.**
- **The size of this outer flow is usually that of the object diameter *d*, but when streaming Reynolds number $Re_s = A^2 f/\nu$ is larger than a few units, the outer flow grows and stretches out, becoming several times (up to 8) the size of the object. Outer vortices get closer to the vibration axis.**
- **In applied prospective, these results show the potentiality to mix fluids or resuspend particles within a large space, via the streaming flow.**