

Variety of flow regimes in Taylor-Couette-Poiseuille flow

¹Magdalena Kristiawan, ²Alioune El Faye,
³Mohamed Mahloul, ³Ammar Mahamdia
and ²Vaclav Sobolik

¹UR BIA, INRA, Nantes

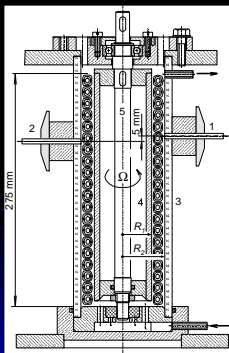
²LaSIE, University of La Rochelle

³Faculty of Physics USTHB, Algiers

Outline

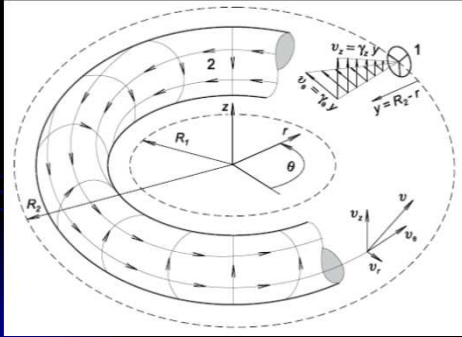
- Experimental set-up
- Measurement of wall shear rate components
- Movie and wall shear rate history
- Parameters of flow regimes
- Conclusions

Experimental



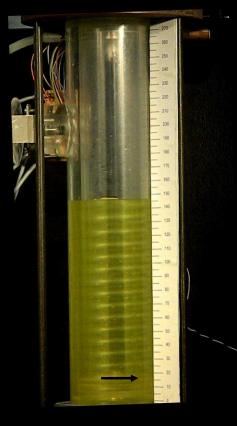
$\eta = R_1/R_2 = 0.804$
 $R_1 = 24.85 \text{ mm}$
 $d = R_2 - R_1 = 6.05 \text{ mm}$
 $\Gamma = L/d = 44$
 $Ta = \Omega R_1 d / \nu \quad (112 - 2513)$
 $7.13 - 160 \text{ rpm}$
 $Re_{ax} = u_m d / \nu \quad (1.9 - 29)$
 $u_m \quad (0.315 - 4.78) \text{ mm/s}$
 $\nu = 10^{-6} \text{ m}^2/\text{s}$

Measurement of wall shear rate components



Filling experiment

$Ta=159$, $Re=5.05$

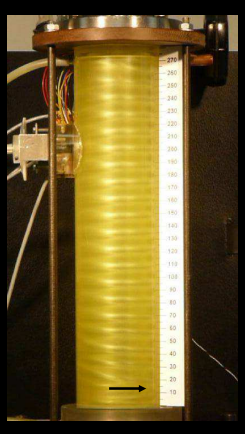
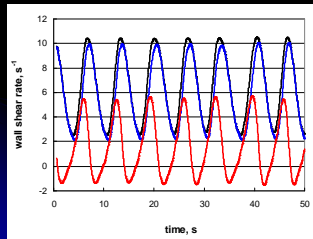


Barber pole effect



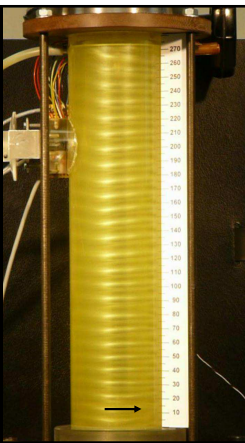
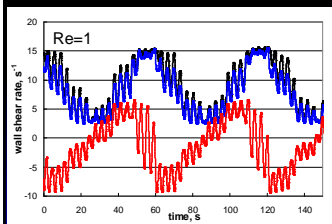
Taylor vortices

$Ta=142$, $Re=10.5$



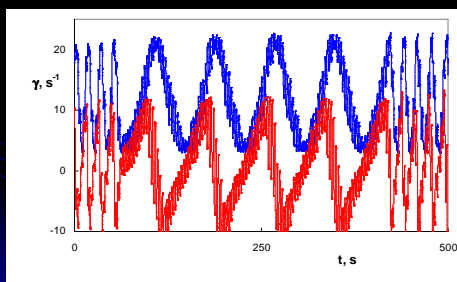
Wavy toroidal vortices 3WV

$Ta=207$, $Re=10.5$



Inertia of vortices

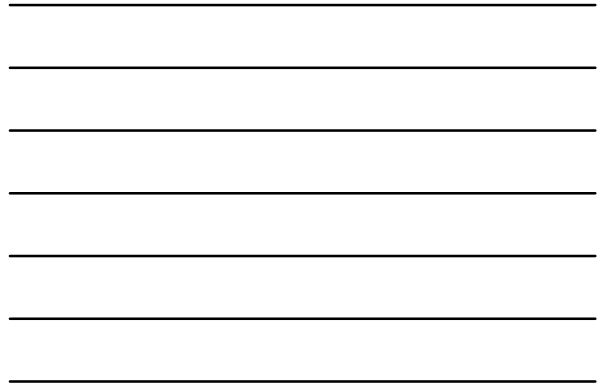
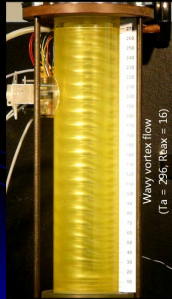
$Ta=224$, $Re = 4.2 \rightarrow 0.88 \rightarrow 4.2$



Wavy toroidal vortices

Ta=296, Re=16.3, 4WV

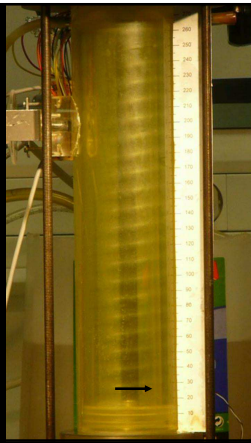
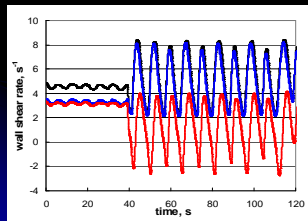
Ta=878, Re=16.3, 2WV



Right helix, H-2

Ta=142, Re=8.5

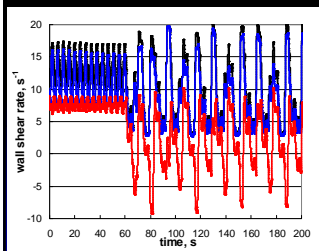
Re = 8.5 → 0

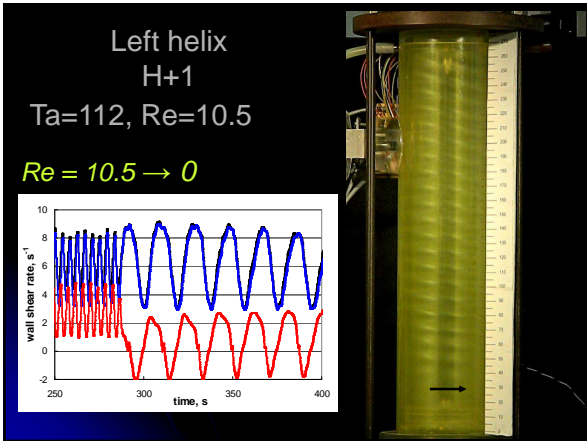
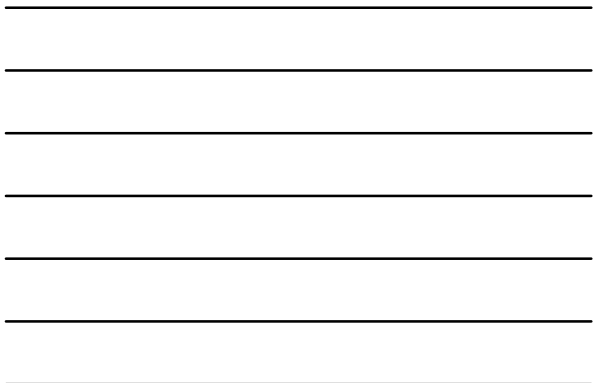
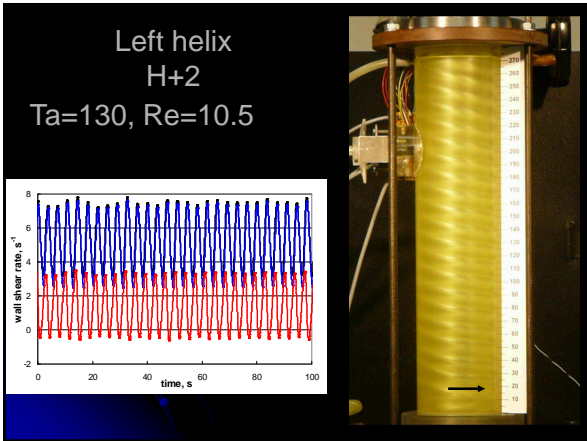
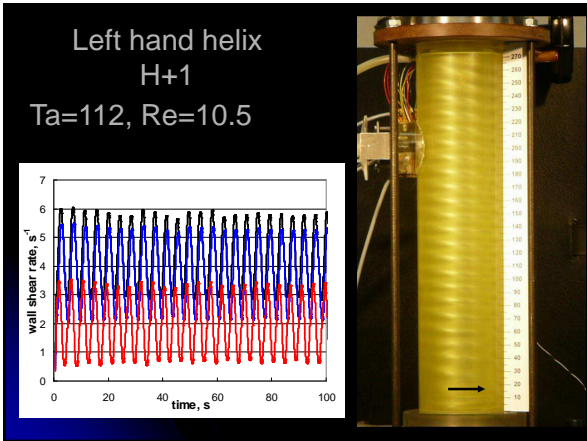


Wavy right helix 4WH-1

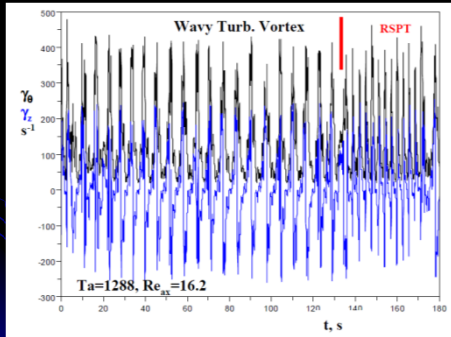
Ta=254, Re=6.3

Re = 6.3 → 0

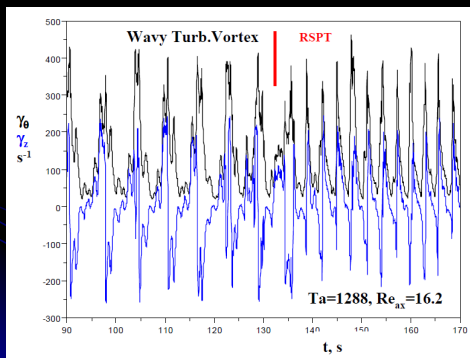




Ta=1288, Re=16.2: TV - WTV - RHTH

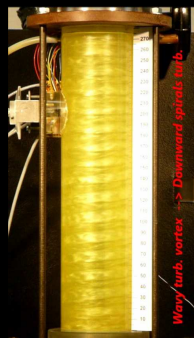
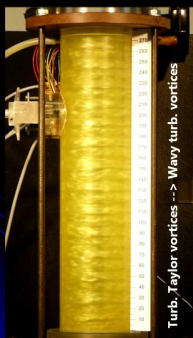


Zoom

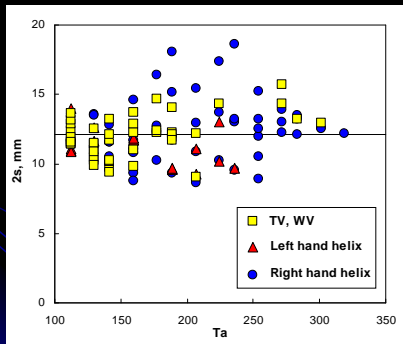


Ta=1644, Re=29

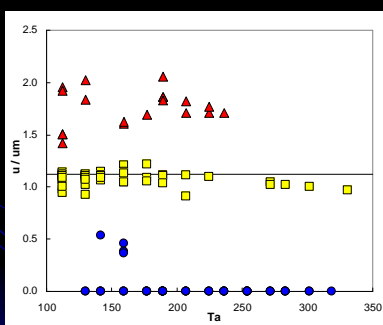
Ta=878, Re=29



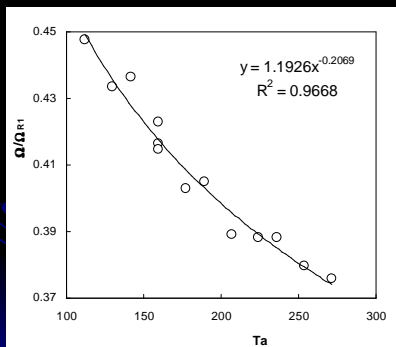
Axial wavelength of vortices



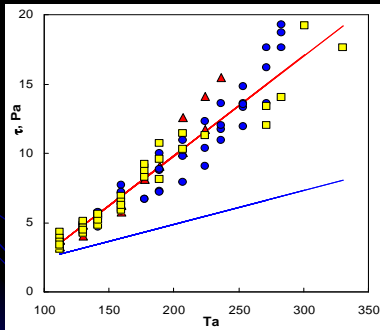
Normalized drifting velocity



Normalized rotation rate of helices



Wall shear stress



Conclusions

- The drifting axial velocity of Taylor vortices and wavy toroidal vortices is about 1.12 multiple of mean axial velocity.
- The axial velocity of helices is composed of the drifting velocity of axial flow and the component due to helix rotation (barber pole effect). The drifting velocity of helices equals to that of the toroidal vortices
- The right handed helices are either steady or they move with a velocity inferior the axial mean velocity. The left handed helices moves always at a velocity superior the axial mean velocity.
- The angular velocity of helices normalized by angular velocity of the inner cylinder is in the interval 0.45 – 0.37. The normalized angular velocity of wavy toroidal vortices is about 0.33.

Thank you for
your attention