Pipes!

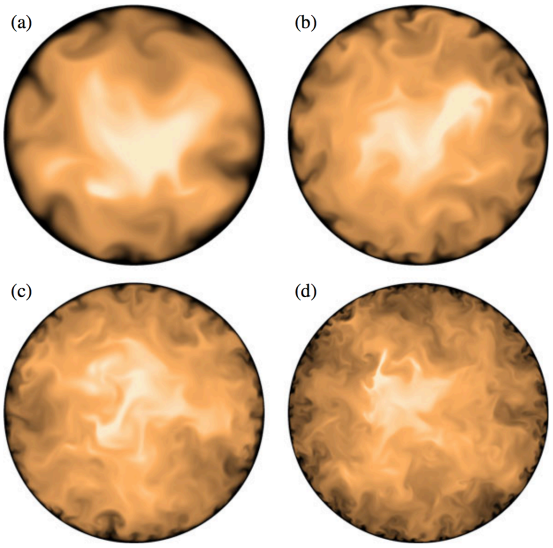
1

Reynolds' Experiment

2

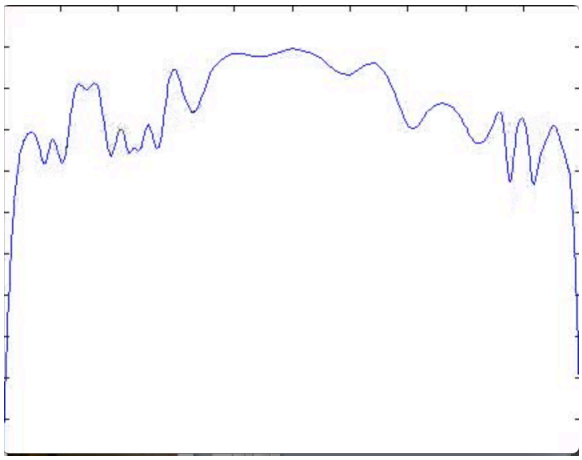
https://www.youtube.com/watch?v=oApDhs4xtaY

Turbulent Pipe Flow



G.K. El Khoury et al., Flow Turbulence, and Combustion, 91:475-495 (2013)

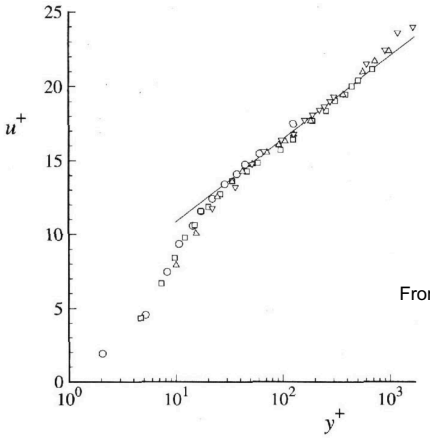
Flow Simulation



Analyse the Data

- Have profiles of velocity: u(x)
  - Lots of instantaneous values
  - Want the statistics
    - Mean
    - RMS
- Excel
  - Load data file: pipe_data.txt
    - columns are x, u1, u2, …
  - Plot data
  - Apply functions
- Try flipping and mirroring the data…

Experimental Comparison



From S.B. Pope, *Turbulent Flows*

Fig. 7.7. Mean velocity profiles in fully developed turbulent channel flow measured by Wei and Willmarth (1989): ○, $Re_0 = 2{,}970$; o, $Re_0 = 14{,}914$; **A**, $Re_0 = 22{,}776$; V, $Re_0 = 39{,}582$; line, the log law, Eqs. (7.43)–(7.44).

Compare the Data to Correlations

- $u^+ = u/u_\tau$
- $(R-r)^+ = (R-r)/\delta$
- Here, $u_\tau=1$, $\delta=0.001$
- Compare to correlations:

$$u^+ = \ln(R-r)^+ \qquad u^+ = \frac{1}{\kappa}\ln(R-r)^+ + B$$

K=0.41, B=5.2

– Plot u^+ vs $\ln(R-r)^+$