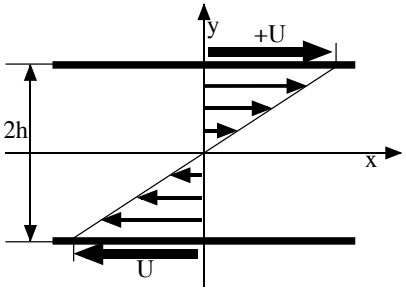
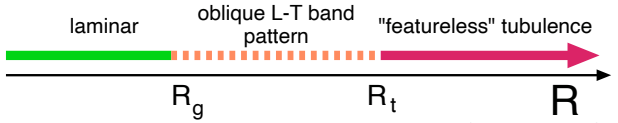
Patterning in the upper transitional range of pCf

Paul Manneville[1] & Masaki Shimizu[2]
[1]Hydrodynamics Laboratory, CNRS-UMR7646, École Polytechnique, Palaiseau, 91128 France
[2]Graduate School of Engineering Science, Osaka University, Toyonaka, 560-0043 Japan



plane Couette flow $\rightsquigarrow$ simple shear, $R = Uh/\nu \rightsquigarrow$



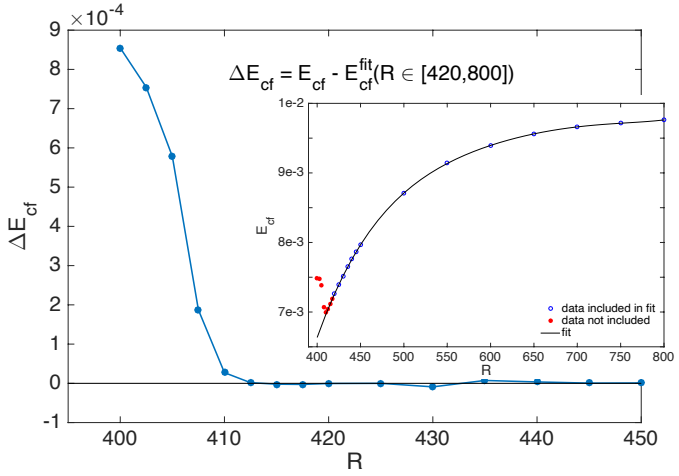
$R_g \sim 330$, $R_t \sim 415$ [Saclay Gr., 1995–2003]; **focus on $R \sim R_t$ and above** ($\nearrow$ 800)

– numerical simulations, program by M.S. (NIFS's "Plasma Simulator")

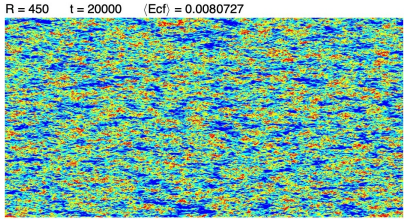
– wide domain $500 \times 2 \times 250$, long durations, statistically steady states

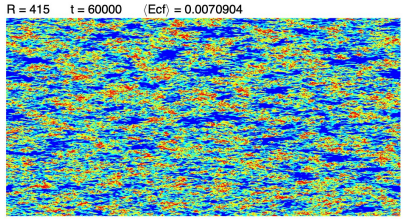
fully resolved ($2304 \times 64 \times 2304$), consider <u>mean cross-flow ener.</u> $E = \frac{1}{2}\int(u_y^2 + u_z^2)\mathrm{d}y$

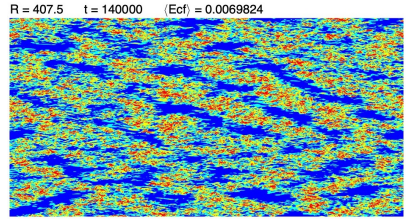
global view using $\overline{\langle E \rangle}$



pictures in physical space, $R = 450$, $R = 415$, $R = 407.5$

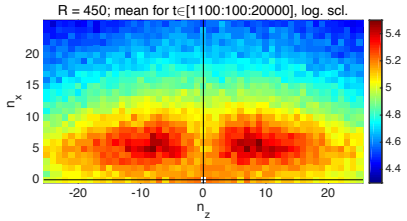


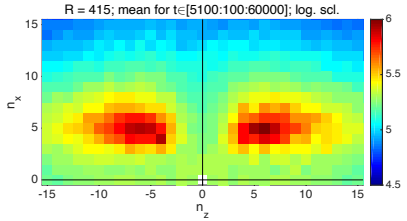


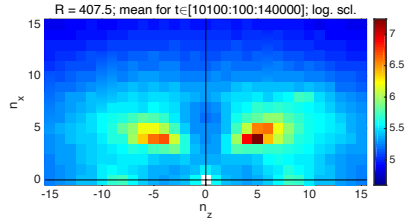


in Fourier space $\rightsquigarrow \widehat{E}(n_x, n_z; t_k) \rightsquigarrow S = |\widehat{E}|^2$; time-average: $\overline{S}(n_x, n_z)$

$\rightsquigarrow$ keep $n_x \geq 0$; from bumps to peaks as $R \searrow$

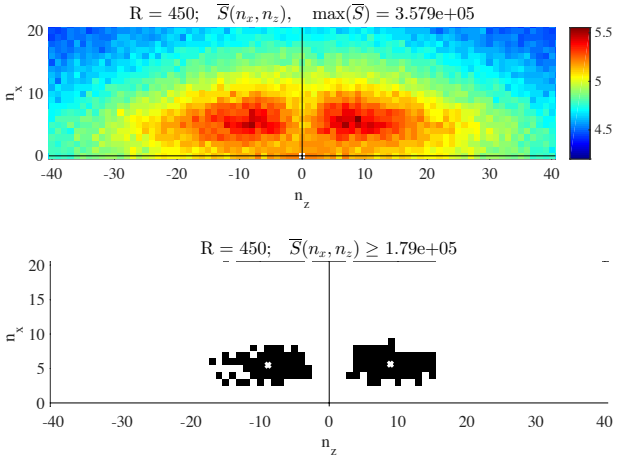






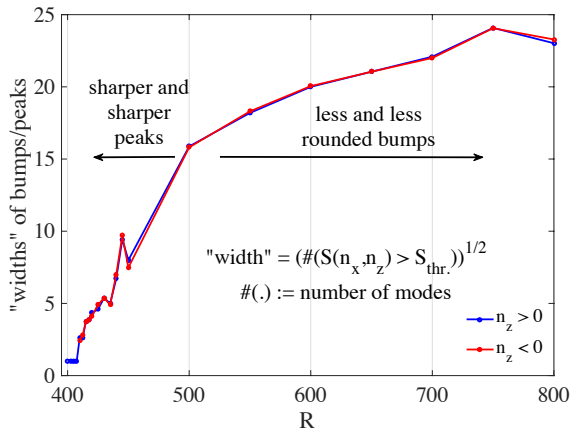
N.B.: E contains no direct contribution from SSP at MFU size $(\ell_x, \ell_z) \approx (13, 4)$ $\Rightarrow$ no need for filtering small scales ($\neq E_t$ including streamwise component u_x) $\rightsquigarrow$ study <u>centre</u> of $\overline{S}$ at decreasing R.

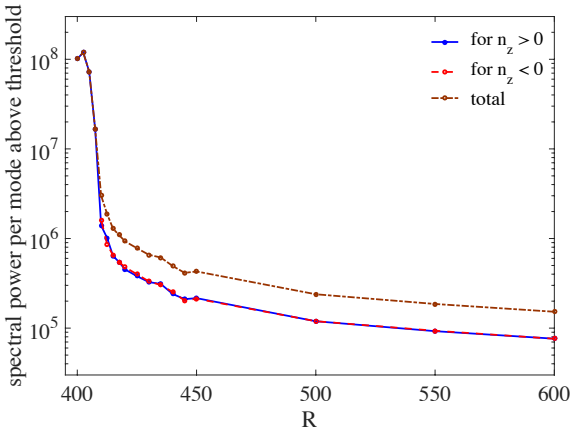
work with barycentre of modes $\overline{S}(n_x, n_z)$ above $\frac{1}{2}\max(\overline{S})$

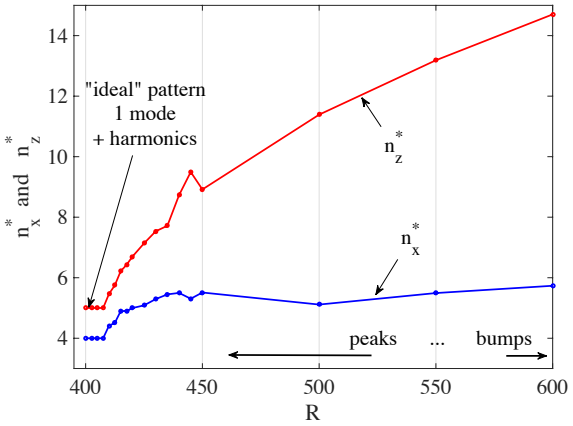


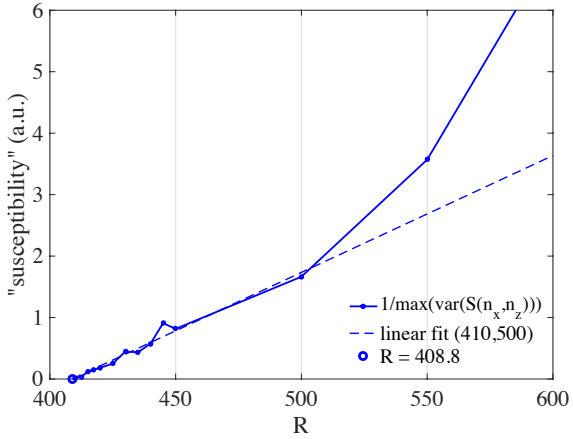
$\rightsquigarrow$ peak positions, widths, and amplitudes

proto-patterning ca. $R \approx 500$
bumps $\rightsquigarrow$ peaks $\rightsquigarrow$ focussing
$R \lessapprox 410$: single mode + harm.
disentangle orientations $\rightsquigarrow$ Ginzburg–Landau amplitudes



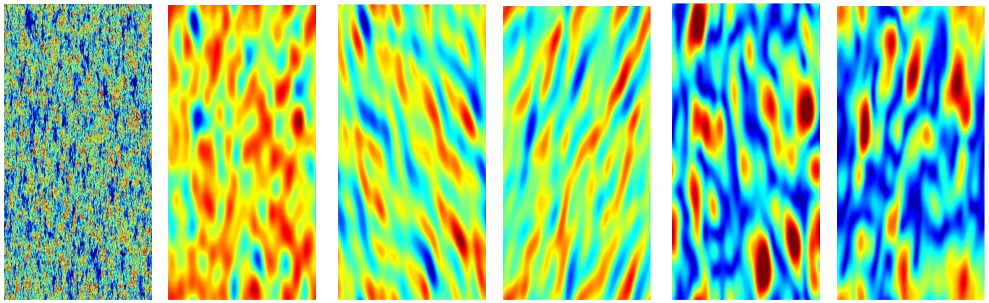






example near onset $R = 420$, waves and amplitudes

raw filt. W_L W_R A_L A_R



still in progress

◇fully resolved 2D numerical simulation, wide domain

◇ pattering around $R_\mathrm{t} = 410$, continuous crossover
no trace of hysteresis or turbulence reentrance
2nd-order mean-field transition subjected to noise

◇ demodulation in "featureless" regime works as intelligent filtering, substantiates concept of "proto-patterning" (angle & wavelength)

◇ challenge: which 2D mechanisms for such oblique large scale modulations from first principles but free of 0D (MFU) or 1D (MBU) limitations?