노트 제목 2010-05-27

Coarse DNS — DNS with large-size mesh

↳ wrong physics
dangerous

100 x 100 x 100
→ 200 x 200 x 200 – 8 times
$\Delta t \rightarrow \Delta t/2$ → 2 times
16 times

150 x 150 x 150

RANS – 2D
100 x 100
↓
200 x 200

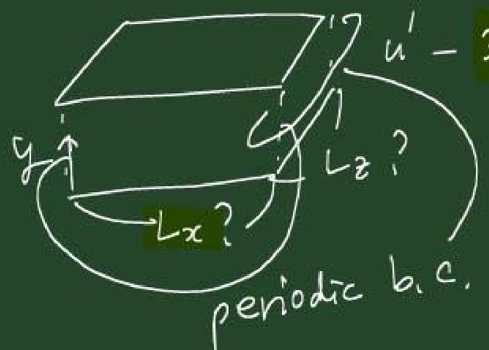
DNS – 3D

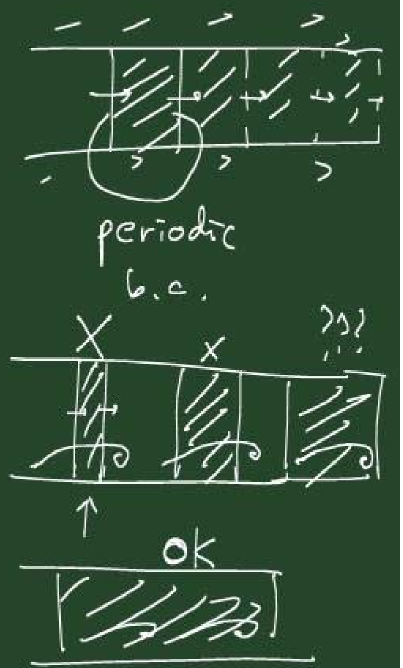
• Computational domain size

turbulent channel flow

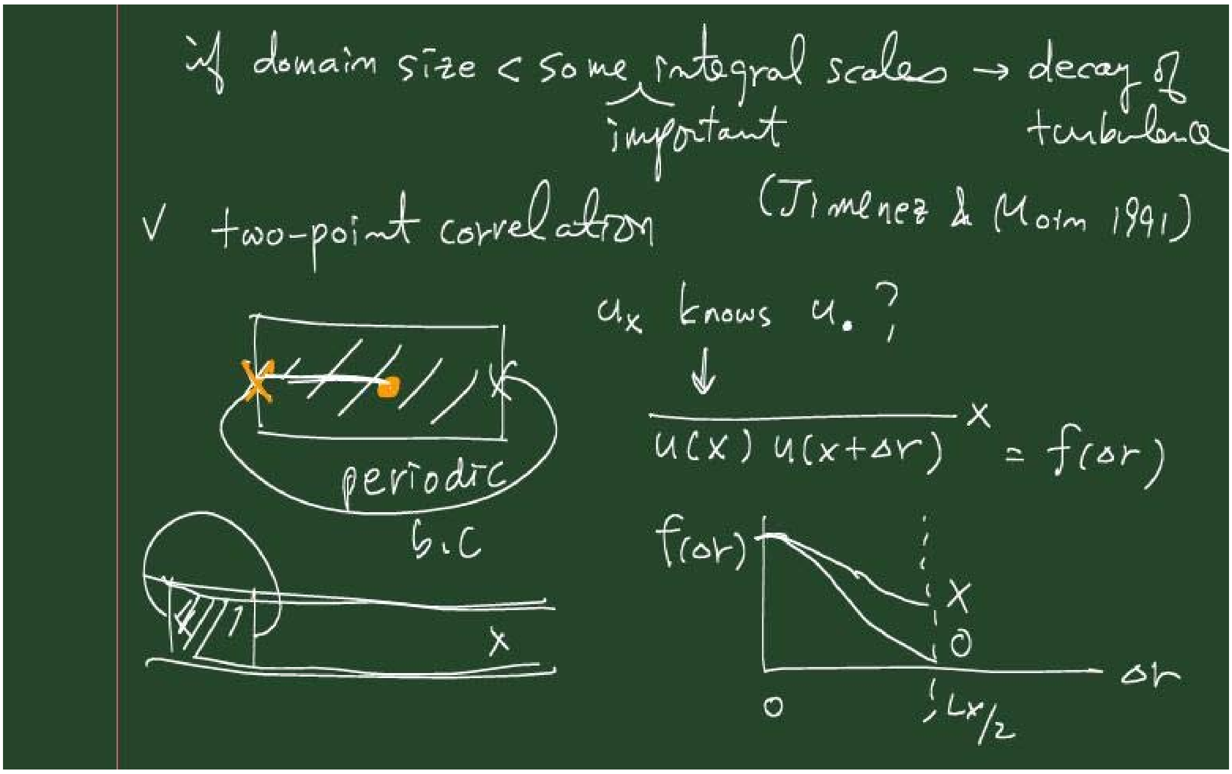
mean quantity – 1D $\bar{u}(y)$

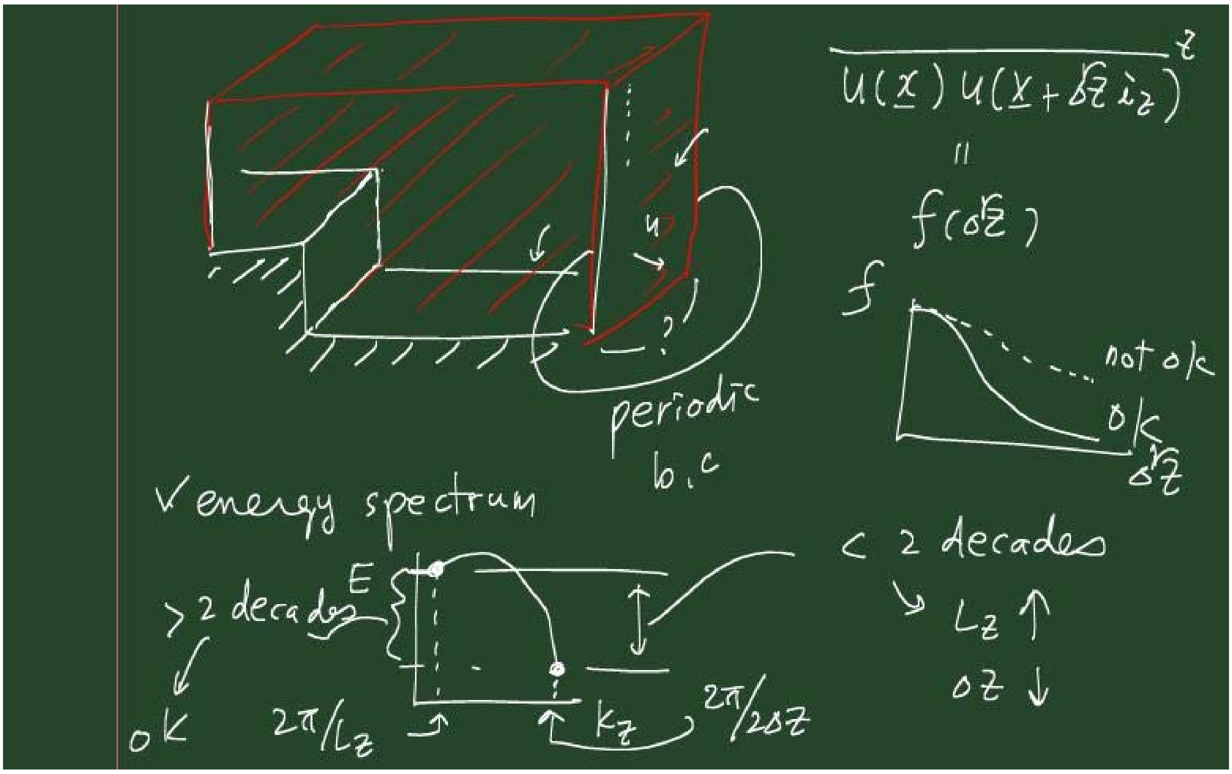
u' – 3D





✓ computational domain size
> 2 x (largest eddy size)


if domain size < some integral scales → decay of turbulence
important
✓ two-point correlation (Jimenez & Moin 1991)
u_x knows u_0 ?
$\overline{u(x)\,u(x+\Delta r)}^{x} = f(\Delta r)$
periodic b.c
f(Δr)
x
o
Δr
0
$L_x/2$


$\overline{u(\underline{x})\,u(\underline{x}+\delta z\, i_z)}^{z}$
=
$f(\delta z)$
u
?
periodic b.c
f
not ok
ok
δz
✓ energy spectrum
< 2 decades
→ L_z ↑
δz ↓
> 2 decades
E
ok
$2\pi/L_z$
k_z
$2\pi/2\delta z$

- Number of grid point requirement (N)

$$\eta/L \sim Re^{-3/4} \rightarrow N \sim \left(\frac{L}{\Delta x}\right)^3 \sim \left(\frac{L}{\eta}\right)^3 \sim Re^{\frac{9}{4}}$$

requirement is very severe!

typically $N \sim 10^6 \sim 10^7$ for low Re # flow.

impossible for high Re # flow

- Why DNS?

→ understanding flow physics from $u_i(\underline{x},t)$ & $p(\underline{x},t)$

→ DNS database is used for

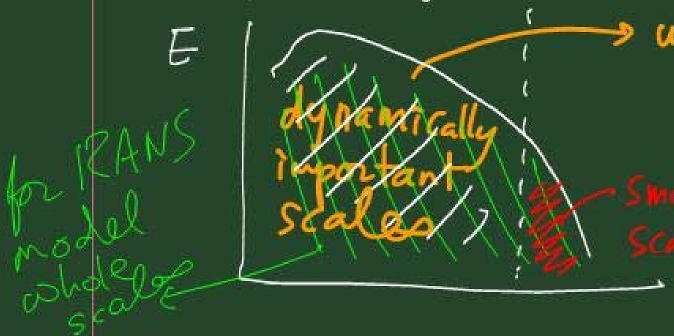
$\overline{p'u'}$ developing turbulence models.

↓

low-Re turbulence models

→ investigating turbulence-control strategies.

☆ Large Eddy Simulation (LES) (w/o turb. model)



→ use unsteady 3-D N-S eq. to solve for those scales

small scales → model these small scales

↓ provide proper amount of dissipation

→ the motions that are resolved are dynamically important ones and
the errors introduced by modelling small-scale motions are significantly smaller than those incurred in RANS where the entire turbulence stresses are modelled.