

Exercise 6

Fluid Dynamics II SS 2022

8.6.2022

1 Exercise: Wind tunnel measurement

Continue to analyze the datasets in the folder wind_data/LCA, which were measured at 20kHz and in m/s.

- Determine the energy spectrum $E(k)$ by using a Fourier transform of the signal.
- Compute a histogram of the velocity increments $u(x+r) - u(x)$ for different scales r .
- Are the probability density functions self-similar?

2 Exercise: von Karman-Howarth relation

Repeat the derivation of the von Karman-Howarth relation between longitudinal and transverse from the correlation tensor

$$C_{ij}(\mathbf{r}, t) = (C_{rr}(r, t) - C_{tt}(r, t)) \frac{r_i r_j}{r^2} + C_{tt}(r, t) \delta_{ij}, \quad (1)$$

in the lecture.

Hint: Show that the incompressibility of the velocity field implies $\frac{\partial}{\partial r_j} C_{ij}(\mathbf{r}, t) = 0$ and use the relation $\frac{\partial}{\partial r_j} f(r) = \frac{\partial f(r)}{\partial r} \frac{r_j}{r}$.