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Coherence of velocity fluctuations in a turbulent jet

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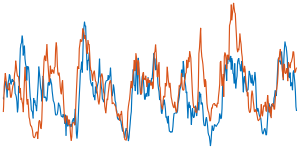
Coherence (C)

$$C_{xy}(f) = \frac{|G_{xy}(f)|^2}{G_{xx}(f)G_{yy}(f)}$$

$$G_{xy}(f) = \int_{-\infty}^{\infty} \langle x(t)y(t+\tau)\rangle e^{-i2\pi f\tau} d\tau$$

- $C(f) = 1$ at frequencies where signals are identical
- $C(f) = 0$ at frequencies where signals are non-identical
- $0 < C(f) < 1$ otherwise

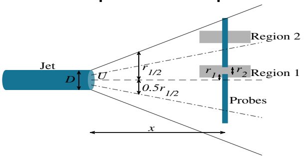


[1] G. Prabhudesai et al., PRL (2022)
[2] H. Tennekes, J. Fluid Mech. (1975)
[3] S. Chen et al., Physics of Fluids A: Fluid Dynamics (1989)
[4] N. Tobin et al. J. FLuid Mech. (2018)

History

- Large scale behavior is recently investigated in turbulent flows with small mean velocity and $C(f) \propto e^{-f/f_c}$ is reported [1].
- In high mean velocity turbulent flows, $C(f) \propto e^{(-f/f_c)^2}$ is predicted [2-4].

Experimental setup

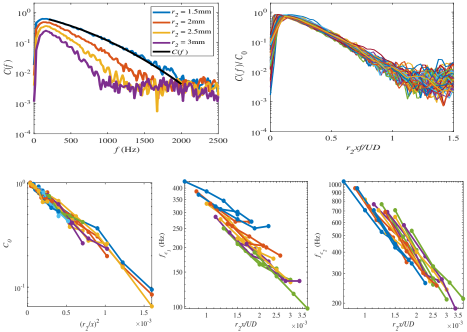


D	Jet diameter
x	Jet to probes distance
U	Jet injection velocity
r_1	First probe to axis distance
r_2	Probes seperation
$r_{1/2}$	Half width

Results

Region 1

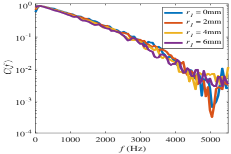
$$C(f) = C_0 e^{-f/f_{c1} - (f/f_{c2})^2}$$



r_1 dependence

Region 1

$$C(f) = C_0 e^{-f/f_{c1} - (f/f_{c2})^2}$$



Region 2

$$C(f) = C_0 e^{-f/f_c}$$