

MOTIVATION

- For Eulerian field measurement at specific time instant
- Kolmogorov (K41) relation of second order structure function ($m = 1$) and spatial distribution
- Bandi (2017) found the asymptotic field limit for wind power power spectrum scale as $r^{4/3}$.
- Notation: $S^{2m}(r) = ((\Delta u^m(r))^2)$

DIMENSIONAL ARGUMENT

Dimensional argument

Experimental data show for high order velocity moments

HYPOTHESES ON TURBULENCE

H1: Galilean invariance restored in field averaged limit
 K41 dimensional scaling is recovered

H2: Galilean invariance not restored and h.o. terms exert themselves

→ $S^2(r)_{\text{field}} \sim r^{2/3}$ as expected

STATISTICAL ANALYSIS

Second order structure function

$m = 2$

Method for calculating $S^2(r)_{\text{field}}$

Single point ($N=1$)

Asymptotic limit ($N=2$ points)

→ $S^2(r)_{\text{field}} \sim r^{2/3}$

→ $S^2(r)_{\text{field}} \sim r^{2/3}$ as expected

→ $S^2(r)_{\text{field}} \sim r^{2/3}$ as expected

REFERENCES

- Taylor, *Proc. R. Soc. Lond. A* **164** (1938)
- Kolmogorov, *Dokl. Akad. Nauk SSSR* **30** (1941a)
- Dutton & Deaven, *Statistical Models and Turbulence. Lecture Notes in Physics* **12** (1972)
- Van Atta & Wyngaard, *J. Fluid. Mech.* **72** (1975)
- Bandi, *Phys. Rev. Lett.* **118** (2017)

Convergence of $S^m(r)$ with N

Scaling exponent α_m

Number of points N

N=20 spatially distributed points can properly describe the asymptotic behavior of $S^m(r)_{\text{field}}$ in an Eulerian field measurement.

CONCLUSIONS AND FUTURE LEADS

- In 3D turbulence, $S^m(r) \sim r^{2m/3}$, $\forall m$.
- Galilean invariance recovers for a sparse spatial sampling (N=20 points).
- Original analysis of the second order structure function.
- In 2D turbulence, results will come up soon!
- Theoretical approach.

Échantillonnage et comportement asymptotique en moyenne spatiale en turbulence

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Échantillonnage et comportement asymptotique en moyenne spatiale en turbulence

- Pour une **mesure Eulérienne d'un champ turbulent à un instant spécifique donné**

Kolmogorov (K41)

$$S_2^1(r) \sim r^{2/3}.$$

- Correspondance pour une **mesure Eulérienne d'une série temporelle**
Hypothèse de Taylor (turbulence gelée)

$$S_2^1(r) \sim r^{2/3} \Leftrightarrow S_2^1(\tau) \sim \tau^{2/3},$$

avec $r = v_{\text{mean}} \tau$.

- Bandi (2017)
La limite asymptotique d'un champ turbulent dans le cas d'un champ éolien évolue comme $\tau^{4/3}$.



→ Comment les spectres temporels de vitesses d'ordre supérieurs $S_2^m(\tau)$ évoluent-ils pour $m > 1$?

1 point (N = 1)	Limite asymptotique (N > 1 points)
$S_2^m(\tau)_{\text{pt.}} \sim \tau^\alpha, \forall m$	$S_2^m(\tau)_{\text{field}} \sim \tau^\alpha, \forall m$
$\alpha = 2/3$	$\alpha \rightarrow 4/3 \text{ or } 2m/3 ?$