

WALL TURBULENCE AND ROUGHNESS

Maurizio Quadrio

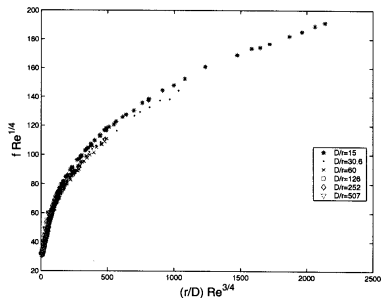
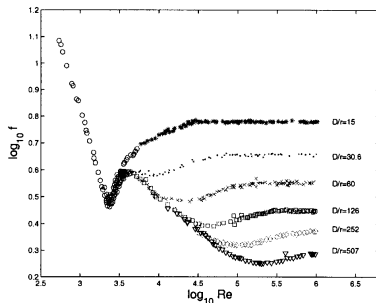
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PARAMETRIZATION OF ROUGHNESS

WE ARE NOT YET CAPABLE OF DESCRIBING A ROUGH SURFACE!

- Scaling of sand-roughness in the whole Re range

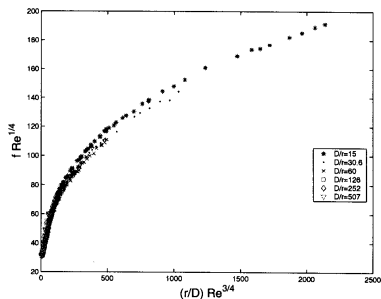
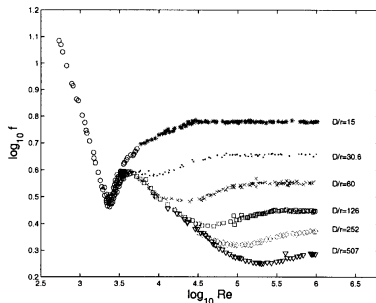


- Today: scaling of many roughness types via $k_{s,\infty}$

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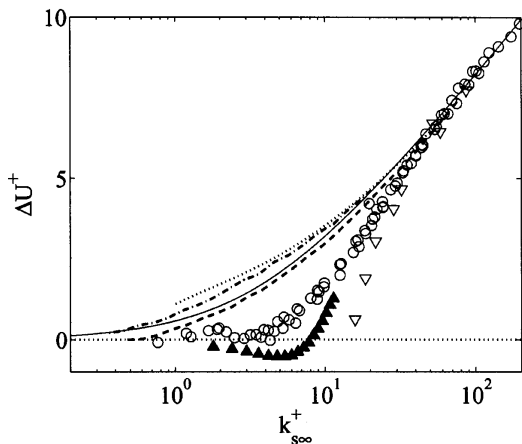
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REDUCTION OF TURBULENT FRICTION

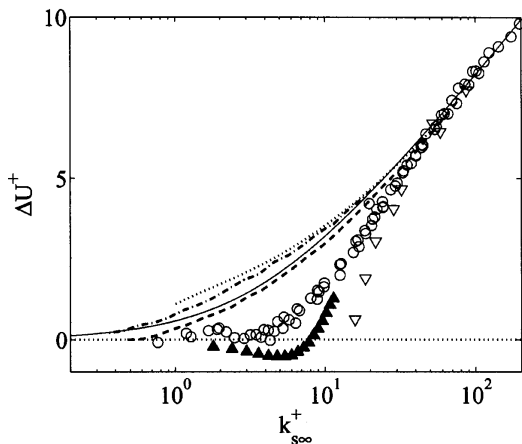
DESIGN OF BETTER-THAN-SMOOTH SURFACES



- Riblets
- V-shapes [Picture](#)
- Others?
- Selection of one longitudinal length scale

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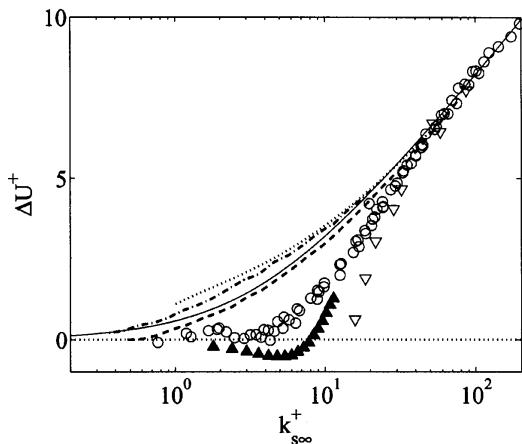
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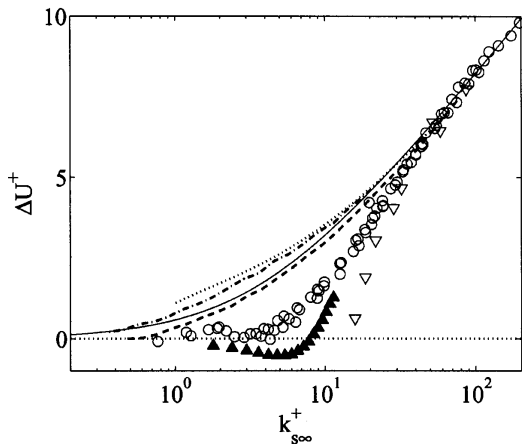
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TBL ON ROUGH SURFACES

HOW DOES ROUGHNESS AFFECT THE WHOLE BOUNDARY LAYER?

SEVERAL OPEN QUESTIONS

- Difference between k -type and d -type roughness?
- How far does roughness influence the various statistical quantities?
- How does roughness affect the anomalous scaling of Re stresses?

ANSWER

Very accurate data in the fully-rough regime with $k \ll \delta$: CICLoPE

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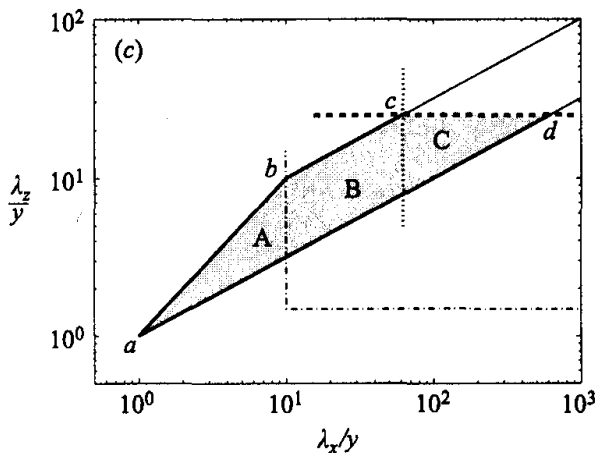
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ANOMALOUS SCALING OF SPECTRAL QUANTITIES

WITH A VIEW TO CHANNEL VS. PIPE COMPARISON



- Models of fluctuation spectra need assessment
- Region B is particularly complicated

REFERENCES

- Goldenfeld, 2005. Roughness-induced critical phenomena in a turbulent flow. arXiv:/cond-mat/0509439, September 16th, 2005.
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- Sirovich & Karlsson, 1997. Turbulent drag reduction by passive means. Nature v.388.
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