

Contents

1	Introduction	1
1.1	Outline	7
2	Homogeneous turbulence	9
2.1	Kolmogorov’s theory for homogeneous turbulence K41	9
2.2	Energy dissipation random field	13
2.3	Scale uniform dissipation random field: intermittency models	16
2.3.1	Log-normal model K62	16
2.3.2	She-Leveque model	18
2.4	The search for more general models	21
3	Non-homogeneous turbulence	23
3.1	Non-uniform energy dissipation random field	23
3.2	Extended Self similarity	24
3.3	Dubrulle model	27
3.4	BDF non-homogeneous model	29
3.4.1	Energy transfer	29
3.5	Non-local dynamics	30
3.6	Transfer hierarchy	35
4	Experimental set-up	41
4.1	Hot-wire anemometer	41
4.2	Velocity response	42
4.3	Determination of fluctuating components	43
4.3.1	Single sensor	43
4.3.2	X-configuration	44
4.4	Constant-temperature anemometry	45
4.5	Calibration of probe	47
4.6	Measurement and data processing	48
4.7	Acoustic Doppler Velocimeter (ADV)	49

4.7.1	Doppler principle	50
4.7.2	Signal-to-Noise Ratio (SNR)	50
4.7.3	Seeding and distance from sampling volume to boundary	50
4.7.4	Ordinate system and calibration	51
4.8	Characteristic parameters of the flows investigated	52
4.9	Flow configurations	53
4.9.1	Grid turbulence	55
4.9.2	Cylinder wake turbulence	56
4.9.3	Jet turbulence	58
5	Experimental results from the laboratory	61
5.1	Energy spectrum	61
5.2	Third-order structure function	66
5.3	Absolute scaling exponent	72
5.4	Relative scaling exponent	76
5.5	Behavior of ζ_3 , $(\delta_\infty - \delta_0)$ and Δ	80
5.6	Intermittency	86
5.6.1	Intermittency parameter μ	86
5.6.2	Intermittency parameter β	87
5.7	Probability distribution functions	89
5.8	Jet and grid flows	94
5.8.1	Absolute energy transfer	94
5.8.2	Third-order structure function	95
5.8.3	Absolute scaling exponent ζ_3 and relative scaling exponent ζ_p/ζ_3	97
5.9	Intermittency parameters μ and β	99
6	Geophysical flows	103
6.1	Experimental setup	104
6.2	Absolute energy transfer	106
6.3	Velocity structure functions	108
6.4	The absolute scaling exponent ζ_p	113
6.5	The relative scaling exponents ζ_p/ζ_3	114
6.6	Intermittency parameters μ and β	117
6.7	Energy Spectrum	119
6.8	Probability distribution functions (PDF)	121
7	Conclusions	123
A	Homogeneous intermittency model	127
A.1	The β -model	127
A.2	The random β -model	130

Bibliography

133

