
Contents

<i>Preface</i>	xi
<i>Foreword</i>	xvii
0 Introduction	1
0.1 Dimensional analysis and physical similarity	1
0.2 Assumptions underlying dimensional analysis	9
0.3 Self-similar phenomena	14
0.4 Self-similar solutions as intermediate asymptotics. The solutions of the first and second kind. Renormalization group	18
0.5 Self-similarities and travelling waves	26
1 Dimensions, dimensional analysis and similarity	28
1.1 Dimensions	28
1.2 Dimensional Analysis	39
1.3 Similarity	52
2 The construction of intermediate-asymptotic solutions using dimensional analysis. Self-similar solutions	64
2.1 Heat propagation from a concentrated instantaneous source	64
2.2 Phenomena at the initial stage of a nuclear explosion	76
2.3 Self-similarity. Intermediate asymptotics	86
3 Self-similarities of the second kind: first examples	95
3.1 Flow of an ideal fluid past a wedge	95
3.2 Filtration in an elasto-plastic porous medium: the modified instantaneous heat source problem	104

4	Self-similarities of the second kind: further examples	119
4.1	Modified very intense explosion problem	119
4.2	The von Weizsäcker–Zeldovich problem: an impulsive loading	133
5	Classification of similarity rules and self-similarity solutions. A recipe for the application of similarity analysis	145
5.1	Complete and incomplete similarity	145
6	Scaling and transformation groups. Renormalization group	161
6.1	Dimensional analysis and transformation groups	161
6.2	The renormalisation group and incomplete similarity	171
7	Self-similar solutions and travelling waves	181
7.1	Solutions of travelling-wave type	181
7.2	Burgers shock wave – steady travelling wave of the first kind	183
7.3	Flame: steady travelling wave of the second kind	185
7.4	Nonlinear eigenvalue problem	192
7.5	Flame propagation in a reacting mixture: an intermediate asymptotics	194
8	Invariant solutions: asymptotic conservation laws, spectrum of eigenvalues, and stability	200
8.1	Asymptotic conservation laws	200
8.2	Spectrum of eigenvalues	203
8.3	Stability of invariant solutions	209
9	Scaling in the deformation and fracture of solids	220
9.1	Transition from self-similarity of the first kind to self-similarity of the second; a linear elasticity problem	220
9.2	Similarity laws for brittle and quasi-brittle fracture	234
10	Scaling in turbulence	252
10.1	Homogeneous and isotropic turbulence	252
10.2	Turbulent shear flows	268
11	Scaling in geophysical fluid dynamics	296
11.1	Scaling laws for the atmospheric surface layer	296
11.2	Flows with strongly stable stratification	299
11.3	The regime of limiting saturation of a turbulent shear flow laden with sediment	301

11.4	Upper thermocline in the ocean – the travelling thermal wave model	306
11.5	Strong interaction of turbulence with internal waves. Deepening of the turbulent region	311
11.6	The breaking of internal waves and extension of mixed-fluid patches in a stably stratified fluid	316
11.7	Several phenomena related to turbulence in a stably stratified fluid	329
12	Scaling: miscellaneous special problems	334
12.1	Mandelbrot fractals and incomplete similarity	334
12.2	Example: scaling relationship between the breathing rate of animals and their mass. Fractality of respiratory organs	342
12.3	The spreading of a ground-water mound	345
	<i>Afterword</i>	360
	<i>References</i>	366
	<i>Index</i>	383