# Contents


**1 Waves and Instabilities in Space Plasmas** ..... 1
K. Papadopoulos
1.1 Introduction ..... 1
1.2 Plasma Description – Response Function – Generalized Ohm's Law 2
1.3 Examples of Plasma Waves in Space – Isotropic Plasmas ..... 4
1.4 Properties of Plasma Waves in Isotropic Plasmas ..... 8
1.5 Generation of Plasma Waves ..... 14
1.6 Plasma Instabilities ..... 22
1.7 Electromagnetic Emission from Isotropic Plasmas ..... 29
1.8 Type III Radio-Bursts – Puzzles and Resolution – The Triumph of Strong Turbulence Theory ..... 34
1.9 Epilogue ..... 41
References ..... 42

**2 Solar MHD: An Introduction** ..... 45
C. Chiuderi and M. Velli
2.1 Introduction ..... 45
2.2 Plasma Physics and Magnetohydrodynamics ..... 46
2.3 A Quick Tour of the Sun ..... 51
2.4 Plasma Instabilities ..... 54
2.5 Coronal Heating, Waves, and Turbulence ..... 60
References ..... 68

**3 An Introduction to Fluid and MHD Turbulence for Astrophysical Flows: Theory, Observational and Numerical Data, and Modeling** .... 71
V. Carbone and A. Pouquet
3.1 Introduction ..... 71
3.2 Fundamental Equations ..... 74
3.3 The Problem of Intermittency in Turbulence ..... 85
3.4 Modeling Turbulence ..... 92
3.5 Theoretical Approaches ..... 111




Bibliografische Informationen
http://d-nb.info/994680007

digitalisiert durch DEUTSCHE NATIONAL BIBLIOTHEK

3.6 Conclusions and Perspectives ..... 117
Appendix A: Data Analysis of Real Turbulent Field ..... 121
Appendix B: Transition to Chaos in Low-Order Galerkin Approximations . 123
Appendix C: About the Word *Intermittency* Encountered in Literature .... 125
References ..... 126

**4 The Solar Atmosphere** ..... 129
V.H. Hansteen and M. Carlsson
4.1 Introduction ..... 129
4.2 The Photosphere ..... 131
4.3 The Chromosphere ..... 136
4.4 Coronal Heating ..... 143
References ..... 154

**5 The Solar Flare: A Strongly Turbulent Particle Accelerator** ..... 157
L. Vlahos, S. Krucker, and P. Cargill
5.1 Introduction ..... 157
5.2 Observational Constraints ..... 159
5.3 Models for Impulsive Energy Release ..... 176
5.4 Particle Acceleration in Turbulent Electromagnetic Fields ..... 189
5.5 Discussion of the Global Consideration of Particle Acceleration ... 214
5.6 Summary ..... 216
References ..... 217

**6 Diagnostics of the Solar Wind Plasma** ..... 223
K. Issautier
6.1 Introduction ..... 223
6.2 Measuring the Key Parameters in the Inner Heliosphere ..... 224
6.3 Measuring the Key Parameters of the Solar Wind ..... 227
6.4 Comparison of Solar Wind Plasma Parameters ..... 236
6.5 Large-Scale Variations of the Heliosphere ..... 240
6.6 Summary and Perspectives ..... 244
References ..... 244

**7 Physical Processes in the Solar Wind** ..... 247
M. Velli
7.1 The Solar Wind ..... 247
7.2 Hydrodynamics of a Featureless Solar Wind Expansion: Why the Solar Wind Is Supersonic ..... 248
7.3 A Wind-Accretion Hysteresis Cycle ..... 254
7.4 Solar Wind Energetics and Empirical Solar Wind Models ..... 257
7.5 Alfvénic Fluctuations and the Solar Wind ..... 260
References ..... 267

**8 Physics of Stellar Coronae** ..... 269
M. Güdel
8.1 Introduction ..... 269
8.2 Stellar Coronae – Defining the Theme ..... 271
8.3 The Coronal Hertzsprung–Russell Diagram ..... 271
8.4 Non-flaring Radio Emission from Stellar Coronae ..... 272
8.5 Thermal X-ray Emission from Stellar Coronae ..... 277
8.6 The Structure of Stellar Coronae ..... 286
8.7 Stellar Radio Flares ..... 300
8.8 Stellar X-ray Flares ..... 303
8.9 The Statistics of Flares ..... 315
8.10 A Flare-Heating Approach ..... 319
References ..... 322