

# Contents

Preface	ix
<b>1. Introduction</b>	<b>1</b>
1.1. Definition of a Plasma	1
1.2. Geophysical Plasmas	5
1.3. Magnetospheric Currents	8
1.4. Theoretical Approaches	9
<b>2. Single Particle Motion</b>	<b>11</b>
2.1. Field Equations	11
2.2. Gyration	12
2.3. Electric Drifts	15
2.4. Magnetic Drifts	18
2.5. Adiabatic Invariants	22
<b>3. Trapped Particles</b>	<b>31</b>
3.1. Dipole Field	32
3.2. Bounce Motion	33
3.3. Drift Motion	38
3.4. Sources and Sinks	41
3.5. Ring Current	43
<b>4. Collisions and Conductivity</b>	<b>47</b>
4.1. Collisions	47
4.2. Plasma Conductivity	52
4.3. Ionosphere Formation	56
4.4. Ionospheric Conductivity	65
4.5. Ionospheric Currents	67
4.6. Auroral Emissions	70

<b>5. Convection and Substorms</b>	<b>73</b>
5.1. Diffusion and Frozen Flux . . . . .	73
5.2. Convection Electric Field . . . . .	79
5.3. Corotation and Plasmasphere . . . . .	82
5.4. High-Latitude Electrodynamic . . . . .	85
5.5. Auroral Electrojets . . . . .	89
5.6. Magnetospheric Substorms . . . . .	92
5.7. Substorm Currents . . . . .	96
<b>6. Elements of Kinetic Theory</b>	<b>103</b>
6.1. Exact Phase Space Density . . . . .	104
6.2. Average Distribution Function . . . . .	108
6.3. Velocity Distributions . . . . .	114
6.4. Measured Distribution Functions . . . . .	120
6.5. Macroscopic Variables . . . . .	124
<b>7. Magnetohydrodynamics</b>	<b>129</b>
7.1. Multi-Fluid Theory . . . . .	129
7.2. Equation of State . . . . .	133
7.3. One-Fluid Theory . . . . .	138
7.4. Stationarity and Equilibria . . . . .	146
<b>8. Flows and Discontinuities</b>	<b>159</b>
8.1. Solar Wind . . . . .	159
8.2. Fluid Boundaries . . . . .	165
8.3. Discontinuities . . . . .	171
8.4. Shocks . . . . .	176
8.5. Bow Shock . . . . .	181
8.6. Magnetopause . . . . .	186
<b>9. Waves in Plasma Fluids</b>	<b>199</b>
9.1. Waves in Unmagnetized Fluids . . . . .	200
9.2. General Dispersion Relation . . . . .	210
9.3. Plasma Wave Energy . . . . .	216
9.4. Magnetohydrodynamic Waves . . . . .	220
9.5. Cold Electron Plasma Waves . . . . .	225
9.6. Two-Fluid Plasma Waves . . . . .	234
9.7. Geomagnetic Pulsations . . . . .	241

<b>10. Wave Kinetic Theory</b>	<b>247</b>
10.1. Landau-Laplace Procedure . . . . .	247
10.2. Landau Damping . . . . .	253
10.3. Unmagnetized Plasma Waves . . . . .	260
10.4. Magnetized Dispersion Relation . . . . .	269
10.5. Electrostatic Plasma Waves . . . . .	272
10.6. Electromagnetic Plasma Waves . . . . .	283
<b>Outlook</b>	<b>295</b>
<b>A. Some Basics</b>	<b>297</b>
A.1. Useful Constants . . . . .	297
A.2. Energy Units . . . . .	297
A.3. Useful Formulas . . . . .	298
A.4. Vectors and Tensors . . . . .	299
A.5. Some Electrodynamics . . . . .	301
A.6. Plasma Entropy . . . . .	305
A.7. Aspects of Analytic Theory . . . . .	306
<b>B. Some Extensions</b>	<b>311</b>
B.1. Coulomb Logarithm . . . . .	311
B.2. Transport Coefficients . . . . .	313
B.3. Geomagnetic Indices . . . . .	315
B.4. Liouville Approach . . . . .	318
B.5. Clemmow-Mullaly-Allis Diagram . . . . .	320
B.6. Magnetized Dielectric Tensor . . . . .	321
<b>Index</b>	<b>325</b>