

Contents

CHAPTER 1	
Introduction	1
References	6
CHAPTER 2	
Fokker–Planck Models of Multispecies Plasmas in Uniform Magnetic Fields	8
2.1. Mathematical Model	8
2.1.1. Fokker–Planck Equations	8
2.1.2. Time-Varying Forces	12
2.1.3. Initial Conditions and Boundary Conditions in Velocity Space	14
2.1.4. Source and Loss Terms in Velocity Space	16
2.2. Solution for a Multispecies Plasma in a One-Dimensional Velocity Space	18
2.2.1. Numerical Methods	18
2.2.2. Applications	23
2.3. Solution in a Two-Dimensional Velocity Space Using an Expansion in Pitch-Angle	28
2.3.1. Numerical Methods	28
2.3.2. Applications	32
2.3.3. Modification of the Lowest Normal Mode Code of Section 2.2 to Include Anisotropic Rosenbluth Potentials	33
2.4. Solution Using Finite-Differences in a Two-Dimensional Velocity Space	34
2.4.1. Numerical Methods	35
2.4.2. Applications	44
References	57
CHAPTER 3	
Collisional Kinetic Models of Multispecies Plasmas in Nonuniform Magnetic Fields	59
3.1. Mathematical Model	59
3.1.1. Bounce-Averaged Fokker–Planck Theory	60
3.1.2. Bounce-Averaged Resonant Diffusion	72
3.1.3. Velocity Space Boundary Conditions	87
3.1.4. Particle and Energy Source and Loss Terms	88
3.1.5. Velocity Space Loss Region Models	90

3.2. Numerical Solution of Bounce-Averaged Fokker–Planck Equations . . .	95
3.2.1. Numerical Methods	95
3.2.2. Bounce-Averaging the Fokker–Planck Coefficients	98
3.2.3. Flux Conservation at the Trapped/Passing Boundary	99
3.2.4. Implicit Time Advancement: Operator Splitting	103
3.3. Applications	109
3.3.1. Neoclassical Corrections to Classical Resistivity	111
3.3.2. Scanning Charge-Exchange Analyzer Diagnostic for Tokamaks . . .	117
Appendix 3A. Coefficients of the Bounce-Averaged Operator.	125
Appendix 3B. Boundary Layer Diagnostic	127
Appendix 3C. Tangent Resonance Phenomena	131
Appendix 3D. Wave Models	135
3D.1. Model Icrft	137
3D.2. Model Icrft0	140
References	140
CHAPTER 4	
A Fokker–Planck/Transport Model for Neutral Beam-Driven Tokamaks	142
4.1. Mathematical Model and Numerical Methods	142
4.1.1. Energetic Ions	142
4.1.2. Bulk Plasma Ions and Electrons	146
4.1.3. Neutrals	151
4.1.4. Fusion	151
4.2. Applications	152
4.2.1. Princeton Large Torus	152
4.2.2. Tokamak Fusion Test Reactor	167
4.2.3. Divertor Injection Tokamak Experiment (DITE)	181
References	194
Index	197