

CONTENTS

THE KINETIC THEORY OF CONVECTIVE TRANSPORT OF FAST PARTICLES IN TOKAMAKS

A. V. Gurevich and Ya. S. Dimant

Introduction	1
1. General Qualitative Discussion	2
1.1. Magnetic Field Ripple	2
1.2. Locally Trapped Particles	5
1.3. The Diffusion Limit	7
1.4. Kinetic Convection	9
1.5. Distortions in the Distribution Functions	10
1.6. Adiabatic Trapping	12
1.7. The Purpose of This Study	16
2. Basic Equations	18
2.1. The Initial Kinetic Equation. The Collision Operator	18
2.2. The Drift-Kinetic Equation.	22
2.3. Curvilinear Coordinate System	27
2.4. Averaging over the Longitudinal Motion (Trapped Particles)	29
2.5. The Smoothed Distribution Function of Banana Particles	33
2.6. Passing Particles	34
2.7. Discussion of the Simplified Equations for Banana and Passing Particles	36
2.8. Locally Trapped Particles	38

2.9.	The KCT Equations	45
2.10.	Thin Tokamak without a Radial Electric Field	48
2.11.	Tokamak with Vertically Uniform Ripple	51
2.12.	Conditions for Applicability of the KCT Equations.	53
3.	Kinetic Convective Transport	56
3.1.	Distribution of Magnetic Field Ripple in Tokamaks.	56
3.2.	The Low-Energy Diffusion Limit.	59
3.3.	Convective Transport of Fast Ions	62
3.4.	Transport of Fast Electrons.	69
3.5.	Adiabatic Capture and Loss of Particles	81
3.6.	Convective Transport of Particles and Energy in Tokamaks	86
Appendices		95
A1.	Conservative Transformations	95
A2.	Averaging over a Periodic Variable	97
A3.	Averaging over the Axial Angle in Velocity Space [Derivation of the Drift Kinetic Equation (2.29)].	103
A4.	Averaging over the Longitudinal Particle Motion.	106
A5.	Averaging over the Coordinate ζ	110
References		113

DIFFUSIVE TRANSPORT PROCESSES CAUSED BY RIPPLE IN TOKAMAKS

P. N. Yushmanov

Introduction.	117
1. Particle Trajectories in Tokamak Magnetic Fields with Ripple	119
1.1. Toroidal Magnetic Field Ripple in Tokamaks.	119
1.2. Particle Trajectories in a Ripple Magnetic Field	128
1.3. Collisionless Transitions between Banana and Locally Trapped Particles	139
2. Transport Owing to Locally Trapped Particles	145
2.1. Basic Transport Characteristics of Locally Trapped Particles	145
2.2. Fluxes of Locally Trapped Particles at High Collision Frequencies	153

2.3.	Fluxes of Locally Trapped Particles at Low Collision Frequencies	159
2.4.	Ion Thermal Transport in the Transition Regime	165
3.	Ripple Fluxes of Banana Particles	172
3.1.	Qualitative Analysis of Transport Processes	172
3.2.	Transport Processes in the Banana-Drift Regime	182
3.3.	Generalization of the Banana-Drift Kinetic Equation	189
3.4.	Radial Fluxes Produced by Banana Particles	194
4.	Ripple Losses of High-Energy Particles	202
4.1.	Estimate of the Losses of Highly Energetic Particles Using the Kinetic Equation	202
4.2.	Monte Carlo Calculations of Ripple Losses of α -Particles	210
4.3.	Cyclotron Interaction of High-Energy Particles with a Toroidal Field Ripple	215
Appendices		220
A1.	Magnetic Field Ripple in Tokamaks with Circular Coils	220
A2.	Correction to the Ripple Transport of Locally Trapped Particles Including the Boundary Layer	223
A3.	Transport Coefficients with Arbitrary Trapping Probabilities for the Banana Particles	227
A4.	Resonance Transport of Banana Particles	231
A5.	Radial Fluxes for Arbitrarily Shaped Magnetic Surfaces	236
References		240

ELECTRON MAGNETOHYDRODYNAMICS

A. S. Kingsep, K. V. Chukbar, and V. V. Yan'kov

1. General Concepts	243
2. Convective Skin Phenomena in Plasmas	247
2.1. Nonlinear Skin Effect	247
2.2. The Skin Effect in the Presence of Charged-Particle Beams.	251
3. Stable Two-Dimensional Electron Vortices	255
3.1. Vortices as Fundamental Objects	255
3.2. Vortices in Uniform Plasmas	256

3.3. A New "Universal" Two-Dimensional Equation in a Weakly Inhomogeneous Medium	258
3.4. Stable Vortices and Solitons in Nonuniform Plasmas . .	261
3.5. Pseudo-Two-Dimensional Vortices	263
4. Turbulence and EMH Resistance	266
4.1. Stable Three-Dimensional Vortices and Three-Dimensional Turbulence	266
4.2. EMH Resistance	268
5. The Z-Pinch	273
5.1. EMH Effects in the Z-Pinch	273
5.2. Electron Flows in Low-Density Pinches	275
5.3. The Resistive Pinch	278
6. Generation of Magnetic Fields	279
7. EMH Effects in Experiments	284
Conclusion	288
References	288