

Contents

1	Introduction	1
1.1	Preamble	1
1.2	Ion Transport in Fusion Devices	3
1.2.1	Fundamental Concepts	3
1.2.2	Geometrical Considerations	5
1.2.3	The Distribution Function	7
1.2.4	Neoclassical Transport	9
1.3	Guiding Center Dynamics	10
1.3.1	Movement of the Guiding Center	11
1.3.2	Collision Operator	13
1.3.3	Stochastic Equations for the Guiding Center	15
1.4	Stochastic Differential Equations	16
1.4.1	A Short Review on Probability Theory	16
1.4.2	The Wiener Process	18
1.4.3	Stochastic Differential Equations	22
1.4.4	Numerical Methods	25
	References	26
2	ISDEP	29
2.1	Introduction	29
2.2	Description of the Code	29
2.2.1	The Monte Carlo Method	31
2.2.2	ISDEP Architecture	33
2.2.3	Output Analysis: Jack-Knife Method	35
2.2.4	Computing Platforms	37
2.2.5	Steady State Calculations	38
2.2.6	NBI-Blip Calculations	39
2.2.7	Introduction of Non Linear Terms	40
2.3	Benchmark of the Code	42
2.4	Overview of Previous Physical Results	44
2.4.1	Thermal Ion Transport in TJ-II	45
2.4.2	CERC and Ion Confinement	45
2.4.3	Violation of Neoclassical Ordering in TJ-II	45

2.4.4	Flux Expansion Divertor Studies	46
	References	46
3	3D Transport in ITER	47
3.1	Introduction	47
3.2	The ITER Model	49
3.3	Numerical Results	52
3.3.1	Confinement Time	53
3.3.2	Map of Escaping Particles	55
3.3.3	Outward Fluxes and Velocity Distribution	57
3.3.4	Influence of the Electric Potential	59
3.4	Conclusions	60
	References	61
4	Simulations of Fast Ions in Stellarators	63
4.1	Stellarators	63
4.1.1	LHD	65
4.1.2	TJ-II	66
4.2	Fast Ions in Stellarators	69
4.2.1	Ion Initial Conditions	72
4.2.2	Steady State Distribution Function	74
4.2.3	Fast Ion Dynamics: Rotation and Slowing Down Time	76
4.2.4	Escape Distribution and Confinement	79
4.3	Comparison with Experimental Results	81
4.3.1	Neutral Particle Diagnostics in TJ-II	82
4.3.2	Reconstruction of the CNPA Flux Spectra	85
4.3.3	Neutral Flux and Slowing Down Time	92
4.4	Conclusions	94
	References	95
5	Simulations of NBI Ion Transport in ITER	97
5.1	Fast Ion Initial Distribution	97
5.2	NBI Ion Dynamics in ITER	99
5.2.1	Inversion of the Current	104
5.2.2	Oscillations in E	106
5.3	Heating Efficiency	107
5.4	Conclusions	109
	References	109
6	Overview and Conclusions	111
	References	114

Appendix A: Index of Abbreviations	115
Appendix B: Guiding Center Equations	117
Curriculum Vitae	125