

1. Record Nr.	UNINA9910634046603321
Autore	Militello Fulvio
Titolo	Boundary plasma physics : an accessible guide to transport, detachment, and divertor design // Fulvio Militello
Pubbl/distr/stampa	Cham, Switzerland : , : Springer, , [2022] ©2022
ISBN	9783031173394 9783031173387
Descrizione fisica	1 online resource (534 pages)
Collana	Springer Series on Atomic, Optical, and Plasma Physics ; ; v.123
Disciplina	306.4409113
Soggetti	Plasma (Ionized gases)
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di bibliografia	Includes bibliographical references and index.
Nota di contenuto	Intro -- Preface -- Acknowledgements -- Contents -- 1 Introduction -- 1.1 Essential Elements of Fusion Physics -- 1.2 The Plasma Exhaust Problem -- 1.3 Boundary Physics at a Glance -- 1.4 Goals and Synopsis -- References -- 2 Plasma Equations -- 2.1 Forces and Dynamics -- 2.2 Kinetic Description -- 2.2.1 Liouville Equation and Probability Distributions -- 2.2.2 Boltzmann and Vlasov Equation -- 2.3 A Basic Discussion of Plasma Collision Operators -- 2.3.1 From Collisions to Collision Operators -- 2.3.2 Boltzmann's H-Theorem, or a Short History of Irreversibility -- 2.3.3 Simplifying Things: The BGK Operator -- 2.4 Fluid Description -- 2.4.1 Density Equation -- 2.4.2 Momentum Equation -- 2.4.3 Energy Equation -- 2.5 Implication of Non-relativistic Dynamics -- 2.6 Closures, Orderings and Reduced Models -- 2.6.1 Braginskii Equations -- 2.6.2 MHD -- 2.6.3 Drift-Ordered Equations -- 2.6.4 Geometry in Reduced 2D Systems -- References -- Further Reading -- 3 Sheath Physics -- 3.1 The Langmuir (or Debye) Sheath -- 3.2 Debye Shielding -- 3.3 A Quick Review of Wall Models -- 3.4 Wall with Perpendicular Magnetic Field or Non Magnetised Plasma -- 3.4.1 Fluid Sheath Model and Existence Conditions -- 3.4.2 Particle Fluxes and Electrical Phenomena in the Sheath -- 3.4.3 Collisional Presheath -- 3.4.4 Kinetic Treatment of the Sheath -- 3.4.5 Bohm Criterion for Plasmas with Multiple Ions -- 3.4.6 Sheath Energy Transmission: Formerly (and Wrongly) Known as Heat Transmission -- 3.5 Wall with

Inclined Magnetic Fields and Magnetic Pre-sheath -- 3.5.1 Bohm Criterion for Shallow Angles and Magnetic Pre-sheath -- 3.5.2 Electric Potential and Dependence on the Incidence Angle -- 3.5.3 Effect of Fluid Drifts -- 3.5.4 Very Shallow Angles and Role of Collisions -- References -- Further Reading -- 4 Atomic, Molecular and Plasma-Surface Physics.

4.1 A Few Useful Concepts and Reaction Terminology -- 4.2 Basic Model with Atomic Hydrogen -- 4.2.1 Electron-Neutrals Interactions -- 4.2.2 Ion-Neutral Interactions -- 4.2.3 Other Interactions Between the Electrons, Ions, and Atoms -- 4.3 Molecular Interactions -- 4.4 Impurities -- 4.5 Plasma-Surface Interactions -- 4.5.1 Reflection, Trapping and Desorption -- 4.5.2 Wall Recycling -- 4.5.3 Sputtering -- 4.5.4 Electron Emission -- References -- Further Reading -- 5 Basic Exhaust Concepts -- 5.1 Magnetic Geometry and Its Connection with the Boundary Plasma -- 5.2 Protecting the Plasma Facing Structures -- 5.3 Elementary Estimates of Scrape-Off Layer Width -- 5.4 Simple Geometrical Effects-Flux Expansion and Tile Tilting -- 5.4.1 Poloidal and Toroidal Flux Expansion -- 5.4.2 Target Tilting -- 5.4.3 Total Flux Expansion and Magnetic Projection of the Areas -- 5.4.4 Further Observations on the Geometrical Effects -- 5.5 Divertor Regimes: The Two Point Model -- 5.5.1 Derivation of the Two Point Model -- 5.5.2 General Solutions of the Two Point Model -- 5.5.3 Collisionality and Its Role in the Two Point Model -- 5.5.4 Applications of the Two Point Model: Divertor Regimes -- 5.5.5 Extended Two Point Model -- 5.6 Flux Formulation and Parallel Profiles in the Boundary Plasma -- 5.6.1 Neutrals and Particle Sources -- 5.6.2 Particle Flux -- 5.6.3 Energy Flux and Temperature Profile -- 5.6.4 Target Conditions -- 5.6.5 Upstream Conditions -- 5.6.6 Mach Number, Velocity and Density Profiles -- 5.6.7 Electric Potential -- 5.7 Divertor Asymmetry in Low to Intermediate Collisionality -- References -- Further Reading -- 6 Radiation and Detachment -- 6.1 Plasma/Neutral Processes at Large Collisionality and Low Temperature -- 6.1.1 Model Equations for High Collisionality Cold Plasmas -- 6.1.2 A Closer Look at the Energy Transfer Mechanisms in a Cold Pure Plasmas.

6.2 Impurity Radiation and Associated Models -- 6.3 Divertor Asymmetry at High Collisionality or Radiation -- 6.4 Detachment -- 6.4.1 Particle Flux Balance -- 6.4.2 Routes to Detachment: A Qualitative Discussion -- 6.4.3 Role of Pressure Losses and Recombination -- 6.4.4 Partial Detachment and Detachment Onset -- 6.4.5 Deep Detachment: Detachment Window and Stability -- 6.5 MARFES and Stable X-Point Radiation -- References -- 7 Filamentary Transport -- 7.1 Basic Filament Physics and Observations -- 7.1.1 Filament Propagation -- 7.2 Filaments at the Outer Midplane -- 7.2.1 Filament Generation -- 7.2.2 Filament Interactions (or Lack Thereof) -- 7.2.3 Parallel Dynamics of the Upstream Filaments -- 7.2.4 Filaments at the X-Point -- 7.2.5 Response of Filaments to Different SOL Conditions -- 7.3 Filaments in the Divertor Region -- 7.4 The Nature of Boundary Turbulence -- 7.4.1 Important Statistical Concepts and Tools -- 7.4.2 Randomness and Structure in Temporal Fluctuations -- 7.4.3 Diffusion and Spatial Fluctuations -- 7.5 Statistical Models of Filamentary Transport and Upstream Profiles -- 7.5.1 Profiles, Background and Fluctuations -- 7.5.2 Phenomenology of the Upstream Profiles -- 7.5.3 Statistical Framework -- 7.6 Heat Fluxes at the Divertor Target: Wagner-Eich Function -- References -- Further Reading -- 8 Conventional and Alternative Divertors -- 8.1 Single Null Divertor: The ITER Solution -- 8.2 Alternative Divertor Designs -- 8.2.1 Why They Are Needed -- 8.2.2 Beneficial Features in Divertor Design -- 8.3 The X-Divertor -- 8.4 The Super-X Divertor -- 8.5 Double Null Divertor -- 8.6

The Snowflake Divertor and X-Point Target Divertor -- 8.7 Liquid Metals as Plasma Facing Components -- 8.8 What Will the Future Bring? -- References -- Further Reading -- Appendix A -- A.1 Of Vectors and Tensors -- A.2 Viscous Forces in all Their Glory -- References. Index.
