

Contents

Preface v
Acknowledgments vii
Observations on notation xiii

Introduction 1

Chapter 1 Terms derived from the left-hand side of the Boltzmann equation

1. Introductory remarks. Starting point of the deductions 9
2. Notation 12
3. Moments of the left-hand side of the Boltzmann equation 19
4. Moments of the left-hand side of the Boltzmann equation constructed with multipliers based upon the components of the thermal velocities 21
5. Flow equations for a gas without collisions 25
6. Methods of approximation which can be used to close the system of equations 27
7. Evaluation of the moments for a particular form of the distribution function . 33

Chapter 2 Collision effects for particles with spherically symmetric force systems

8. Transfer integrals 39
9. First steps in the evaluation of the transfer integrals 41
10. Introduction of a particular assumption for the form of the distribution function 45
11. The semilinear approximation 48
12. Flow equations for a gas of particles with spherically symmetric force systems in the semilinear and in the fully linear form 58
13. Alternative form of some equations 64

14. Equations for a gas with a single particle species	66
15. Calculation of collision integrals for unrestricted velocity differences with unrestricted temperatures	69

Chapter 3 Applications of the equations obtained in Chapter 2

16. Stationary radial flow of a gas with a single particle species	76
17. Diffusion phenomena in a gas with several species of particles. Flow equations based upon the use of the mean mass flow velocity for the gas	80
18. Diffusion problems	92
19. Thermal diffusion in a binary mixture	95
20. Viscosity of a mixture of two gases	102
21. Viscous forces in a multiple mixture. Diffusion and heat flow in multiple mixtures	105

Chapter 4 Gases with electrically charged particles. Calculation of formal cross sections for resistance coefficients

22. Introduction. The shielding effect	108
23. Binary collisions with Coulomb forces	113
24. Application of a truncated Coulomb potential	116
25. The Fokker-Planck approximation	119
26. Moment equations deduced from the Fokker-Planck equation	123
27. Application of a two-particle distribution function	126
28. Equation for the correlation function F'_{st}	129
29. Reduction of the integral (28.12)	135
30. The remaining integrations in (29.9)	139
31. Estimate of the contribution of the last line of Eq. (28.7). Final result for the resistance coefficient	145

Chapter 5 Application of the flow equations to problems of diffusion, electric conductivity, heat flow, and viscosity in gases with charged particles

32. Diffusion and electric conductivity in a fully ionized gas with a single species of positive ions, not influenced by a magnetic field	150
33. Calculations for an unrestricted velocity difference between ions and electrons and unrestricted temperatures	156
34. Conduction of electric currents in an ionized gas in the presence of a magnetic field	159
35. Diffusion in a fully ionized gas with two species of positive ions	162
36. Diffusion equilibrium in completely ionized hydrogen with a small admixture of heavy positive ions	169

37. Plasma diffusion in a magnetic field	173
38. Electric conductivity and diffusion in a partially ionized gas	180
39. Influence of a homogeneous magnetic field upon the viscosity of a completely ionized gas	190
40. Effects of magnetic forces upon the pressure tensor in a gas in which the collision frequency is small	196
41. Some transformations of the flow equations	202
(I) Parker's equations for the flow components perpendicular to the local direction of the magnetic field	202
(II) New forms of the relation between current and electric field in the presence of a magnetic field (generalized forms of Ohm's law)	204
42. Particle motion in a magnetic field described as cyclotron motion around a drifting center	210
43. Transportation of magnetic lines of force by a moving ionized gas	217
44. Relations between the field variables on the two sides of a shock wave	221

Chapter 6 Application of the Bhatnagar-Gross-Krook approximation for the randomizing effect of collisions

45. Expression to replace the collision integral on the right-hand side of the Boltzmann equation	226
46. Moments of the right-hand side of the Boltzmann equation evaluated on the basis of the Bhatnagar-Gross-Krook approximation	231
47. Complete flow equations based upon the Bhatnagar-Gross-Krook approximation	233
48. Observations on the equations—Equations for a gas consisting of a single particle species	236
49. Alternative form of the flow equations	239
50. Gas consisting of particles with internal energy which is exchanged in all collisions	240
51. Higher approximations to solutions of the Boltzmann equation	247
52. Solution of an equation related to the "Boltzmann-Bhatnagar-Gross-Krook" equation by means of iterated integration	254

Chapter 7 Reactive collisions

53. Extension of the Bhatnagar-Gross-Krook approximation to nonelastic (reactive) collisions	260
54. General form of the flow equations for the system $s + t \rightleftharpoons a + b$	264
55. Calculation of mean values for reactive collisions	267
56. Flow equations for the system $s + t \rightleftharpoons a + b$	272
57. A reaction involving dissociation and recombination	276
58. Observations on the results obtained in Section 57	286
(I) Partial check and supplementary relations	286

(II) Further equilibrium conditions 288

(III) Temperature equations 290

59. Ionization and recombination 291

Chapter 8 Interaction of a gas with a radiation field

60. Introductory considerations. Extension of the Boltzmann equation and construction of moment equations 295

61. The equation of radiative transfer 301

62. Connection of Eqs. (61.17) and (61.20) with the energy and momentum equations for the particles 308

63. Some relativity transformations 312

64. Observations on the coefficients A and B —Line spectra 316

Annotated references to other publications 323

Subject Index 327