

Contents

Introduction

1.	GENERAL CHARACTERISTICS OF FUNDAMENTAL ELECTRON COLLISION PROCESSES	4
1.1	A Basic Electron Scattering Experiment	5
1.2	Collision Parameters of the Electron Motion in Gases	13
1.3	Collisions of Electrons with Single Gas Particles	18
1.4	Electron Collisions in a Finite-Temperature Molecular Gas	25
1.5	Theoretical Values of Collision Parameters	36
	A. Elastic collisions, 36	
	B. Inelastic collisions with molecules, 40	
2.	THE ELECTRON DISTRIBUTION FUNCTION AND THE TRANSPORT PARAMETERS	47
2.1	The Boltzmann Equation	48
2.2	Evaluation of the Boltzmann Term for Typical Cases	50
	A. Single-process scattering by molecules at rest, 50	
	B. Elastic scattering by charged particles at rest, 54	
	C. Scattering by a gas at temperature T_e , 56	
	D. Electron-electron scattering, 61	
2.3	Solutions of Boltzmann Equation	62
2.4	Transport Coefficients	79
2.5	Transport Equations	86
2.6	Derivation of Collision Parameters from Electron Swarm Properties	88
	A. Use of direct current transport parameters when no magnetic field is present, 90	
	B. Use of alternating current transport parameters when no magnetic field is present, 100	

C. Use of direct current transport parameters in a static magnetic field, 115	
D. Use of alternating current transport parameters in a static magnetic field, 118	
3. EXPERIMENTAL METHODS OF MEASURING TRANSPORT PARAMETERS	127
3.1 Common Features of the Experimental Methods	127
3.2 Drift Velocity from Transit Time Measurements: General Description of the Experimental Methods	129
3.3 Drift Velocity Determinations from Transit Time Measurements: Approximation Limits and Related Errors	145
3.4 Tubes and Experimental Techniques Used for the Measurement of Electron Transit Times	162
3.5 Characteristic Energy: General Description of the Basic Measurement Methods	172
3.6 Characteristic Energy Determinations: Error Sources and Secondary Effects	179
3.7 Characteristic Energy: Tubes and Experimental Techniques	190
3.8 Direct Current Conductivity	198
A. Induction probe, 198	
B. Voltage-current characteristic in high-temperature cells, 204	
C. Voltage-current characteristic in Q-machines, 207	
D. Alternating current low-frequency measurements, 208	
3.9 Direct Current Transport Parameters in Static Magnetic Fields	209
A. Magnetic deflection, 209	
B. Diffusion to mobility ratio D_T/μ_{\parallel} in parallel fields, 216	
C. Diffusion to mobility ratio D_{\parallel}/μ_T in crossed fields, 218	
D. Conductivity in crossed fields, 219	
3.10 Free Electron Diffusion	219
A. Diffusion when no magnetic field is present, 219	
B. Diffusion in a static magnetic field, 231	
3.11 High-Frequency Conductivity Ratio	233
A. Propagation of a plane wave, slightly perturbed by an ionized gas, 236	
B. Resonance of a microwave cavity, slightly perturbed by an ionized gas, 254	
C. Measurements in the case of a dense plasma, 265	
3.12 Radiation Temperature Measurements	270

3.13 Thermal Transport Parameters	285
A. General description of the basic experimental methods,	
285	
B. Experimental implementation of the basic methods, 289	
C. Thermal diffusion effects in Q-machines, 297	
3.14 High-Frequency and Thermal Transport Parameters in Magnetic Fields	299
A. High frequency measurements, 299	
B. Measurements of thermal transport parameters, 307	
4. EXPERIMENTAL DETERMINATIONS OF ELECTRON COLLISION PARAMETERS	310
4.1 General Remarks on the Presentation of Measured Transport Data and of Collision Parameter Determinations for the Various Gases	310
4.2 Helium	314
Experimental data, 314	
Determination of collision parameters, 327	
4.3 Neon	329
Experimental data, 329	
Determination of collision parameters, 333	
4.4 Argon	333
Experimental data, 333	
Determination of collision parameters, 345	
4.5 Krypton	347
Experimental data, 347	
Determination of collision parameters, 349	
4.6 Xenon	350
Experimental data, 350	
Determination of collision parameters, 355	
4.7 Hydrogen	355
Experimental data, 355	
Determination of collision parameters, 367	
4.8 Deuterium	375
Experimental data, 375	
Determination of collision parameters, 378	
4.9 Nitrogen	379
Experimental data, 379	
Determination of collision parameters, 386	
4.10 Oxygen	392
Experimental data, 392	

Determination of collision parameters,	396
4.11 Carbon Monoxide	398
Experimental data,	398
Determination of collision parameters,	401
4.12 Carbon Dioxide	404
Experimental data,	404
Determination of collision parameters,	408
4.13 Water Vapor	409
Experimental data,	409
Determination of collision parameters,	413
4.14 Alkali-Metal Vapors	413
Experimental data,	413
Determination of collision parameters,	418
4.15 Other Gases	422
Experimental data,	422
Determination of collision parameters,	425
4.16 Air and Other Mixtures	433
A. Experimental data for dry air and N_2-O_2 mixtures,	433
Theoretical evaluations for dry air,	435
Experimental data for other mixtures,	436
4.17 Positive Ions	437
APPENDIX A Fundamental Constants and Useful Physical Data	445
APPENDIX B Application of Dingle Functions to the Evaluation of the Microwave Conductivity	448
BIBLIOGRAPHY	451
INDEX	467