

Contents

<i>List of Contributors</i>	ix
<i>Treatise Preface</i>	xi
<i>Preface</i>	xiii
1 Upper Atmospheric Physics—Introduction	1
<i>H. S. W. Massey</i>	
2 The Structure of the Terrestrial Atmosphere at Middle Latitudes	
<i>H. S. W. Massey</i>	
I. The Neutral Atmosphere	7
II. Ionization in the Thermosphere—The Main Ionosphere	13
III. Some Basic Data on Upper Atmospheric Atoms and Molecules	17
References	19
3 The Photochemistry of the Midlatitude Ionosphere	
<i>H. S. W. Massey</i>	
I. The Formation of the Ionosphere	22
II. The Atmosphere Explorer Satellites	24
III. The Solar EUV Radiation	27
IV. Rate of Electron and Ion Production in the Thermosphere	30
V. Penetration of Different Wavelengths into the Atmosphere	39
VI. Electron Recombination	39
VII. Ionic Reaction Rates	44
VIII. Application of Laboratory Data to Photochemistry of the Main Ionosphere	52
IX. The F ₂ Region	66
References	72
4 The Thermal Balance in the Thermosphere at Middle Latitudes	
<i>H. S. W. Massey</i>	
I. Introduction	78
II. General Description of the Thermal Balance Associated with Solar UV Radiation	78

III. The Electron and Ion Temperatures	79
IV. The Electron and Ion Temperature in the F Region—Comparison with Observation	92
V. The Radiation Budget and the Neutral Gas Temperature	96
References	102

5 Atomic Collisions and the Lower Ionosphere at Midlatitudes

H. S. W. Massey

I. Introduction	106
II. The Temperature Structure below 120 km	107
III. The Atmospheric Composition in the Mesosphere and Lower Thermosphere	108
IV. Production of the E Region	112
V. Ionizing Radiation below 90 km	114
VI. The Normal D Region	117
VII. The Winter Anomaly	132
VIII. Disturbance of the D Region by Solar Flares	134
IX. Meteor Ionization	135
References	145

6 Airglow and Auroras

D. R. Bates

Part A. NIGHTGLOW

I. Lines	152
II. Band Systems	169
III. Continuum	183

Part B. DAYGLOW

IV. Resonant and Fluorescent Scattering	185
V. Photoelectrons	186
VI. Lines	187
VII. Band Systems	193

Part C. AURORAS

VIII. Impact Excitation	197
IX. Chemical-Ionic Sources	207
X. Proton Auroras	212
References	213

7 The High Latitude Ionosphere, the Exosphere, and the Magnetosphere

H. S. W. Massey

I. The High Latitude Ionosphere	226
II. Photochemistry of the F Region in the Presence of a Diffuse Aurora	227

III.	Model Studies of the High Latitude F Region—The Effect of Electric Fields	229
IV.	The Light Ions, H ⁺ and He ⁺ , and the Polar Wind	233
V.	The Escape of Hydrogen from the Earth	240
VI.	The Helium Escape Problem	245
VII.	Polar Cap Absorption Events	246
VIII.	Ions in the Magnetosphere	249
	References	252

8 The Ionospheres of the Planets and Other Bodies of the Solar System

H. S. W. Massey

I.	Introduction	256
II.	The Inner Planets from Spacecraft	256
III.	General Description of the Upper Atmosphere and Ionosphere of Mars and Venus	258
IV.	Interaction of the Solar Wind with the Planetary Ionospheres	259
V.	Atmospheric Composition and Temperature	260
VI.	The Electron Concentration in the Planetary Ionospheres	262
VII.	The Ion Composition in the Planetary Ionospheres	263
VIII.	The Electron and Ion Temperatures	263
IX.	Photochemistry of the Planetary Ionospheres	266
X.	The Day Airglow: Mars and Venus	271
XI.	The Night Airglow on Venus	274
XII.	Thermal Balance in the Planetary Atmospheres—The Electron and Ion Temperatures	275
XIII.	The Heating Efficiency in the Thermospheres of Mars and Venus	278
XIV.	The Outer Planets and Their Satellites	280
XV.	Ions and Ionic Reactions in Comets	288
	References	289

9 Atmospheric Processes Involved in the Stratospheric Ozone Problem

H. I. Schiff

I.	Introduction	294
II.	Stratospheric Chemistry	297
III.	Atmospheric Models	304
IV.	Predictions of Ozone Depletion by Halocarbons	316
V.	Comparisons between One-Dimensional Models and Atmospheric Measurements	320
VI.	Model Prediction for Halocarbon Releases	326
VII.	Two-Dimensional Model Results	329
VIII.	Estimates of Uncertainties in Model Predictions	329
IX.	Feedbacks and Interactions with Other Pollutants	335
X.	Past Ozone Trends as a Possible Early Warning System	337

XI. Other Possible Threats to the O ₃ Layer	340
XII. Consequences of O ₃ Depletion	341
References	342

10 Solar Physics

Alan H. Gabriel and Helen E. Mason

I. Introduction	346
II. Aspects of Solar Physics Involving Atomic Collisions	347
III. Impact Excitation	353
IV. Ionization and Recombination	364
V. Absolute Spectral Intensities	379
VI. Radiation Effects	387
VII. Conclusions	392
References	392

11 Atomic Collisions in Gaseous Nebulae

H. S. W. Massey

I. Sources of Nebular Radiation	400
II. Radiative Recombination to H Ions	402
III. Radiative Recombination to He ⁺	407
IV. Recombination to Ions of Heavier Elements—Importance of Dielectronic Recombination	409
V. Forbidden Transitions in Nebular Spectra	410
VI. Excitation of Intercombination and Allowed Lines	417
VII. Applications to Observed Nebulae	418
VIII. Excitation through Charge Transfer	423
IX. Energy Balance in Nebulae	425
References	425

12 Molecules in Interstellar Space

A. Dalgarno

I. Introduction	427
II. Excitation in Dense Clouds	430
III. Excitation in Diffuse Clouds	436
IV. Excitation in Shocked Regions	441
V. Molecular Reactions	447
References	462

Index

469