



---

# Contents

---

<b>1. Introduction</b>	1
1.1 Historical Development	1
1.2 Gravitational Effects of Interstellar Matter	4
<b>2. Observations of the Gas</b>	9
2.1 Theory of Emission and Absorption by Gas	9
Basic concepts	9
Excitation and ionization	11
Line emission and absorption	14
Line profile and curve of growth	17
Continuous emission and absorption by hydrogenic atoms	21
Synchrotron emission	22
2.2 Emission from the Gas	24
Hydrogen 21-cm line	24
Visual emission lines	29
Radio continuum and line emission	33
OH emission	35
2.3 Absorption by the Gas	36
Radio lines	37
Visual lines	39
2.4 Nonthermal Emission	44
Observed brightness temperature	45
Energetic particles	47
Interstellar magnetic field	49
<b>3. Observations of the Grains</b>	57
3.1 Theory of Absorption and Scattering by Grains	57
Spheres	59
Cylinders and spheroids	62
Complex particles	64

3.2	Extinction and Scattering by the Grains . . . . .	65
	Selective extinction . . . . .	65
	General extinction . . . . .	69
	Scattering . . . . .	71
3.3	Polarization . . . . .	72
	Dependence on color excess . . . . .	73
	Dependence on wavelength . . . . .	75
	Dependence on galactic longitude . . . . .	76
3.4	Spatial Distribution of Interstellar Matter . . . . .	79
	Visible nebulae . . . . .	80
	Indirect and statistical evidence . . . . .	82
<b>4.</b>	<b>Interactions among Interstellar Particles . . . . .</b>	<b>88</b>
4.1	Collisional Processes . . . . .	88
	Elastic collisions, short-range forces . . . . .	90
	Elastic collisions, electrostatic forces . . . . .	94
	Excitation by electron impact . . . . .	95
	Excitation by atoms . . . . .	98
	Recombination and ionization . . . . .	99
4.2	Excitation and Kinetic Equilibrium . . . . .	101
	Velocity distribution function . . . . .	103
	Excitation . . . . .	106
4.3	Ionization and Dissociation . . . . .	109
	Hydrogen ionization . . . . .	112
	Ionization of sodium and calcium . . . . .	120
	Dissociation equilibrium for molecules . . . . .	125
4.4	Kinetic Temperature . . . . .	126
	H II region of pure hydrogen . . . . .	129
	H II region with impurities . . . . .	133
	H I region . . . . .	136
	Equipartition of kinetic energy . . . . .	140
	Thermal instability . . . . .	141
4.5	Equilibrium Properties of the Grains . . . . .	142
	Temperature of the solid material . . . . .	142
	Electric charge . . . . .	145
	Orientation . . . . .	147
4.6	Evolution of Grains and Formation of Molecules . . . . .	152
	Growth of grains . . . . .	152
	Disruption of grains . . . . .	154
	Molecule formation . . . . .	157

<b>5. Dynamics of the Interstellar Gas</b>	161
5.1 Dynamical Principles and Problems	161
Basic equations	162
Virial theorem	164
Shock fronts	166
Parameters of the interstellar medium	170
Energy balance in cloud collisions	172
5.2 Equilibrium Density Distribution	175
Galactic distribution	176
Distribution perpendicular to the galactic plane	179
Distribution in the galactic disc	181
5.3 Expansion of H II Regions	183
Ionization fronts	184
Initial ionization of the gas	187
Expansion of the ionized gas	188
Efficiency of acceleration	193
5.4 Supernova Shells	194
Initial expansion of a supernova atmosphere	195
Intermediate nonradiative expansion	198
Late isothermal expansion	200
5.5 Interactions between Clouds and Stars	202
Ionization of an H I cloud in an H II region	202
Acceleration of an H I cloud by the rocket effect	205
Radiation pressure on grains near a bright star	207
Radiation pressure of galactic light on grains	210
<b>6. Formation of Stars</b>	214
6.1 Gravitational Instability	214
Linearized perturbation equations	215
Instability of a gaseous disc	217
Collapse of an isolated cloud	220
6.2 Fragmentation of a Collapsing Cloud	225
Uniform nonrotating cloud, $\mathbf{B} = 0$	225
Rotating cloud, $\mathbf{B} = 0$	230
Uniformly magnetized cloud, $\Omega = 0$	232
6.3 Later Stages in Star Formation	234
Radiative decrease of energy	235
Decrease in magnetic flux	238
Decrease in angular momentum	242
<b>Symbols</b>	247
<b>Index</b>	255