

CONTENTS

Preface	1
Chapter 1 Introduction	3
1.1 Historical Sketch, 1	
1.2 Synopsis, 6	
Chapter 2 Light Scattering and Fluctuations	10
2.1 Introduction, 10	
2.2 Fluctuations and Time-Correlation Functions, 11	
2.3 Ensemble-Averaged Time-Correlation Functions, 16	
2.4 The Spectral Density, 18	
Chapter 3 Basic Light Scattering Theory	24
3.1 Introduction, 24	
3.2 Results from Electromagnetic Theory, 25	
3.3 Molecular Approach to Light Scattering, 28	
3.4 Scattering Geometries, 30	
<i>Appendix 3.A Derivation of the Scattered Field, 33</i>	
Chapter 4 The Light Scattering Experiment	38
4.1 Introduction, 38	
4.2 Filter Techniques, 38	
4.3 Optical Mixing Techniques, 39	
<i>Appendix 4.A Fabry-Perot Interferometer, 43</i>	
<i>Appendix 4.B Optical Mixing Experiments, 44</i>	
<i>Appendix 4.C The Gaussian Approximation, 50</i>	
Chapter 5 Model Systems of Spherical Molecules	53
5.1 Introduction, 53	
5.2 Spherical Molecules, 53	
5.3 Dilute Solutions and Particle Independence, 56	
5.4 Heterodyne Correlation Function for Particle Diffusion, 57	
5.5 Homodyne Spectrum for Very Dilute Solutions, 62	
5.6 Dilute Gases, 65	
5.7 Motile Microorganisms, 67	
5.8 Molecules in Uniform Motion, 73	
5.9 Brownian Motion, 83	
<i>Appendix 5.A The Calculation of the Mean-Square Displacement, 86</i>	
Chapter 6 Fluctuations in Chemically Reacting Systems	91
6.1 Introduction, 91	
6.2 Formulation of Model, 92	
6.3 Electrophoresis: The Fast and Slow Exchange Limits, 96	

6.4	No External Fields,	101
6.5	Dimerization Kinetics,	103
6.6	Fluorescence Correlations,	105
6.7	Prospects,	109
	<i>Appendix 6.A The Derivation of the Equation of FFS,</i>	<i>110</i>
Chapter 7	Model Systems Containing Optically Anisotropic Molecules	114
7.1	Introduction,	114
7.2	Scattering from Cylindrically Symmetric Molecules,	115
7.3	Rotational Diffusion of Linear Molecules,	118
7.4	Scattering from Anisotropic Molecules,	123
7.5	Rotational Diffusion of Anisotropic Molecules,	125
7.6	Extended Diffusion Models for Molecular Reorientation,	131
7.7	Macromolecules in Solution,	143
7.8	Application to Small Molecules in Liquids,	144
	<i>Appendix 7.A The Coupling Between Translational and Rotational</i>	<i>Diffusion in Dilute Solution, 149</i>
	<i>Appendix 7.B An Alternative Treatment of Symmetric Top Molecules,</i>	<i>151</i>
	<i>Appendix 7.C Irreducible Tensors in Light Scattering,</i>	<i>157</i>
Chapter 8	Scattering from Very Large Molecules	164
8.1	Introduction,	164
8.2	Angular Distributions of Isotropic Integrated Intensities,	164
8.3	Molecules of Arbitrary Shape,	169
8.4	Molecular Weight Determinations,	171
8.5	Corrections for Finite Concentrations and Polydispersity,	173
8.6	Time-Correlation Functions and Spectral Distributions,	175
8.7	The Correlation Function for Long Rigid Rods,	177
8.8	Gaussian Coils,	182
8.9	Anisotropic Scattering,	188
8.10	Other Models,	192
8.11	Effects of Polydispersity on Time-Correlation Functions and Spectra,	193
8.12	Large Particles,	197
	<i>Appendix 8.A The Fokker-Planck Equation,</i>	<i>198</i>
	<i>Appendix 8.B Form Factor for the Optically Anisotropic Rigid Rod,</i>	<i>200</i>
Chapter 9	Electrolyte Solutions	207
9.1	Introduction,	207
9.2	The Diffusion Equation of a Strong Electrolyte,	207
9.3	External Fields—Electrophoresis,	213
9.4	Macroions,	216
9.5	The Equilibrium Structure Factors,	217
Chapter 10	Light Scattering from Hydrodynamic Modes	223
10.1	Introduction,	223
10.2	Relaxation Equations and the Regression of Fluctuations,	226
10.3	Conservation Equations and Hydrodynamic Modes,	229
10.4	The Rayleigh-Brillouin Spectrum of a Pure Monatomic Fluid,	233
10.5	The Rayleigh-Brillouin Spectrum and Intramolecular Relaxation,	246

10.6	Binary Mixtures,	249
10.7	Critical Opalescence,	257
	<i>Appendix 10.A Ensemble Theory of Fluctuations,</i>	261
	<i>Appendix 10.B Thermodynamic Identities,</i>	262
	<i>Appendix 10.C Thermodynamic Fluctuation Theory,</i>	263
Chapter 11	Methods for Deriving Relaxation Equations	277
11.1	Introduction,	277
11.2	Liouville Space,	277
11.3	Projection Operators and Relaxation Equations,	279
11.4	Slow and Fast Variables,	285
11.5	Symmetry Properties of the Relaxation Equations,	287
11.6	Relaxation of a Single Conserved Variable,	298
	<i>Appendix 11.A Projection Operators in Quantum Statistical Mechanics,</i>	302
	<i>Appendix 11.B An Expression for the Relaxation Rate in Terms of Ordinary Time-Correlation Functions,</i>	303
	<i>Appendix 11.C Additional Theorems Concerning Time-Correlation Functions and Memory Functions,</i>	305
Chapter 12	Cooperative Effects in Depolarized Light Scattering	309
12.1	Introduction,	309
12.2	Kinetic Equations for Orientational Relaxation in Depolarized Scattering,	310
12.3	Comparison Between Single Particle and Collective Reorientation Times,	321
Chapter 13	Nonequilibrium Thermodynamics—Diffusion and Electrophoresis	329
13.1	Introduction,	329
13.2	The Equation of Entropy Balance,	329
13.3	Calculation of the Entropy Production,	330
13.4	The Phenomenological Equations,	332
13.5	Isothermal Diffusion of Uncharged Molecules in a Two-Component System,	334
13.6	Isothermal Diffusion in an Uncharged Multicomponent System,	342
13.7	Electrolyte Solutions,	344
13.8	Electrophoretic Fluctuation Theory,	350
Chapter 14	Collision-Induced Light Scattering and Light Scattering by Gases	357
14.1	Introduction,	357
14.2	A Simple Collisional Model,	358
14.3	The Kinetic Theory of Gases,	364
Chapter 15	Other Probes of Molecular Dynamics	367
15.1	Introduction,	367
15.2	Neutron Scattering,	367
15.3	Raman and Infrared Band Shapes,	368
15.4	Dielectric Relaxation,	371
15.5	Other Methods.	371