Contents

1. **Resonant Multiphoton Interactions and the Generalized Two-Level System** 1
   - 1.1 The Basic Equations Describing the Evolution of Radiation Interacting with Matter 4
   - 1.2 The Truncated Equations for the Density Matrix 8
     - 1.2.1 The Two-Level Model and the First Approximation of the Averaging Method 10
     - 1.2.2 Second-Order Resonances and an Example of the Simultaneous Realization of Two Resonance Conditions 12
     - 1.2.3 The Hamiltonian of the Averaged Motion 15
     - 1.2.4 The Truncated Equations for Resonances of Arbitrary Order Involving Many Levels 17
   - 1.3 Polarization of Matter and the Generalized Dipole Moment .. 21
   - 1.4 The Generalized Two-Level System 25

2. **The Molecular Response to the Resonant Effects of Quasimonochromatic Fields** 27
   - 2.1 The Change of Populations of the Generalized Two-Level System in Quasimonochromatic Fields 27
     - 2.1.1 Saturation of Populations of Resonant Levels and the Effect Which the Level Shift Under the Influence of Light Has on Saturation 28
     - 2.1.2 Balance Equations and Interference of Transition Probability Amplitudes in Resonant Parametric Interactions 34
   - 2.2 Susceptibility in Incoherent Multiphoton Processes 36
     - 2.2.1 Expressions for Susceptibility 36
     - 2.2.2 The Imaginary Part of Susceptibility as a Function of Fields and the Energy Absorbed by Matter 39
     - 2.2.3 The Real Part of Susceptibility for the Single-Photon Resonance 42
     - 2.2.4 The Real Part of Susceptibility for Two-Photon Absorption (TPA) and Stimulated Raman Scattering (SRS) 48
     - 2.2.5 The Real Part of Susceptibility Generated by Light Pulses 51
   - 2.3 Spectroscopy of Polarizabilities of Excited States 54
   - 2.4 Molecular Response for Resonant Parametric Interactions 60

Bibliografische Informationen
http://d-nb.info/870393693

digitalisiert durch DEUTSCHE NATIONAL BIBLIOTHEK

3. **The Dynamics of Quantum Systems for Resonant Interactions with Strong Nonstationary Fields** 63
3.1 The Equation of Motion and Its Properties 63
3.1.1 The Specific Features of the Relaxation of the System in a Strong Quasi-Resonant Field 63
3.1.2 The Equation of Population Motion 67
3.1.3 Equation of Population Dynamics for Two-Photon Processes 70
3.2 Amplitude Modulation for Exact Frequency Resonance, $\omega \equiv 0$ (Exact Solutions) 71
3.2.1 Equal Relaxation Times ($T = \tau$) 72
3.2.2 The Case of Unequal Relaxation Times ($T \neq \tau$) 80
3.2.3 Relaxation in the Field of a Single Pulse for $T \neq \tau$, and Methods for Exact Solutions 87
3.3 Amplitude-Frequency Modulation of the Field (Exact Solutions) 90
3.3.1 The Case of Equal Relaxation Times ($T = \tau$) 90
3.3.2 The Non-Equal Relaxation Times ($T \neq \tau$) 93
3.4 Approximate Solutions in Various Limiting Cases 101
3.5 Relaxation in a Stationary Field 106
3.6 Polarization Dynamics in a Nonstationary Field 108

4. **Polarization of Resonant Media** 111
4.1 Nonlinear Polarization of Gaseous Media 112
4.1.1 Probability of Stimulated Multiphoton Transitions and Polarization of Freely Self-Orienting Systems 112
4.1.2 The Local Coherence of Parametric Interaction 114
4.1.3 Influence of the Doppler Effect on the Shape of the Absorption Line for Multiphoton Interactions ... 117
4.2 Dispersion Properties of the Resonant Susceptibility of Media with Identically Oriented Particles 118
4.3 The Equation for the Nonlinear Susceptibility for the Single-Photon Resonance 123
4.4 The Properties of Spatial Harmonics of Susceptibility 126
4.4.1 Relationships Between Direct and Mixed Susceptibilities 127
4.4.2 The Connection Between Susceptibilities χ, a and b 128
4.4.3 Potential Function for Susceptibilities 130

5. **Structure of One-Dimensional Waves for the Single-Photon Resonance** 132
5.1 Conservation Laws for One-Dimensional Waves in Resonant Media 132
5.2 Stationary Oscillations in a Layer of Identical Molecules Without Distributed Losses 136

5.3 Stationary Oscillations in a Layer of Identical Molecules in the Presence of Distributed Losses 140
5.4 Rotation of Polarization Planes of Countertravelling Waves in an Isotropic Nonlinear Medium 147

6. **Three-Photon Resonant Parametric Processes** 152
6.1 Addition and Doubling of Frequencies for a Transition Frequency in Matter That Coincides with the Sum Frequency or the Frequency of the Harmonic 154
6.1.1 Addition and Doubling of Frequencies in a Medium with Identically Oriented Molecules 155
6.1.2 On Resonant Frequency Doubling in Vapors and Gases 163
6.2 Generation of the Second Harmonic of Resonant Pumping ... 169
6.3 Resonant Division of Frequency 173
6.4 Generation of the Difference Frequency During Stimulated Raman Scattering 178
6.4.1 Generation of Resonant Radiation During SRS in a Medium Consisting of Identically Oriented Molecules .. 179
6.4.2 Generation of the Difference Frequency During SRS in Gases 186
6.4.3 Generation of the Difference Frequency During SRS in the Presence of a Nonuniform Electrostatic Field 193

7. **Four-Photon Resonant Parametric Interactions (RPI)** ... 206
7.1 Anti-Stokes Stimulated Raman Scattering 210
7.1.1 Specific Features of ASRS 210
7.1.2 Basic Equations 211
7.1.3 Spatial Distribution of the Anti-Stokes Component 212
7.1.4 Energy Characteristics of ASRS 215
7.1.5 The Experimental Analysis of Energy Characteristics .. 218
7.2 The Influence of Four-Photon RPIs on the Dynamics of the Stokes Components of SRS 222
7.2.1 Generation of the Stokes Components of SRS During Biharmonic Pumping 222
7.2.2 The Effect of Strong Pumping TPA on Weak Pumping SRS 232
7.2.3 Discussion of Experimental Results 235
7.3 Radiation Frequency Transformation in Four-Photon RPIs Based on Pumping Field TPA and SRS 240
7.3.1 Introductory Remarks and Basic Equations 240
7.3.2 Generation of the Difference Frequency During TPA ... 243
7.3.3 Generation of the Sum Frequency During TPA 246
7.3.4 The Effect of Wave Detuning 248
7.3.5 Transformation Length and Effect of Population Saturation 251

7.3.6 Four-Photon RPI's Based on SRS of the Pumping Field 254
7.3.7 Generation of the Difference Frequency During SRS ... 255
7.3.8 Generation of the Sum Frequency During SRS 257
7.3.9 Discussion 258
7.4 On Soft Excitation of Stimulated Two-Photon Radiation 261

8. Self-Action of Light Beams Caused by Resonant Interaction with the Medium 270
8.1 Specific Features and Threshold Characteristics of Self-Focussing in an Absorbing Medium 270
8.1.1 The Equation for the Beam Radius 272
8.1.2 The Threshold for Weak Attenuation 274
8.1.3 The Threshold for Strong and Intermediate Attenuation 278
8.2 The "Weak" Self-Focussing and Self-Defocussing of a Gaussian Beam in an Absorbing Medium 281
8.3 Self-Bending of Trajectories of Asymmetric Light Beams in Nonlinear Media 284
8.4 Conditions for the Existence of Self-Action Caused by Resonant Absorption 289
8.5 Self-Action of Light Caused by Stimulated Raman Scattering 295
8.5.1 Formation of a Thin Lens in the Region of SRS-Transformation 295
8.5.2 The Threshold of SRS Self-Focussing and Self-Bending . 297
8.6 Self-Action Effects at Nonlinear Interface 301
8.6.1 Nonlinear Properties of Interfaces 301
8.6.2 The Main Equations and Conditions 304
8.6.3 Effects at "Positive" Nonlinearity 306
8.6.4 Experiments on a Nonlinear Interface 309
8.6.5 Effects at "Negative" Nonlinearity Longitudinally Inhomogeneous Traveling Waves (LITW) 313
8.6.6 Theorems of LITW Existence for Arbitrary Kinds of Nonlinearity 317
8.7 Optical Bistability Based on Mutual Self-Action of Counterpropagating Light Beams 318
8.7.1 Experimental Observation of Bistability Based on Self-Trapping 318
8.7.2 Mutual Self-Action of Counterpropagating Beams in the General Case 320

References 327

Subject Index 339